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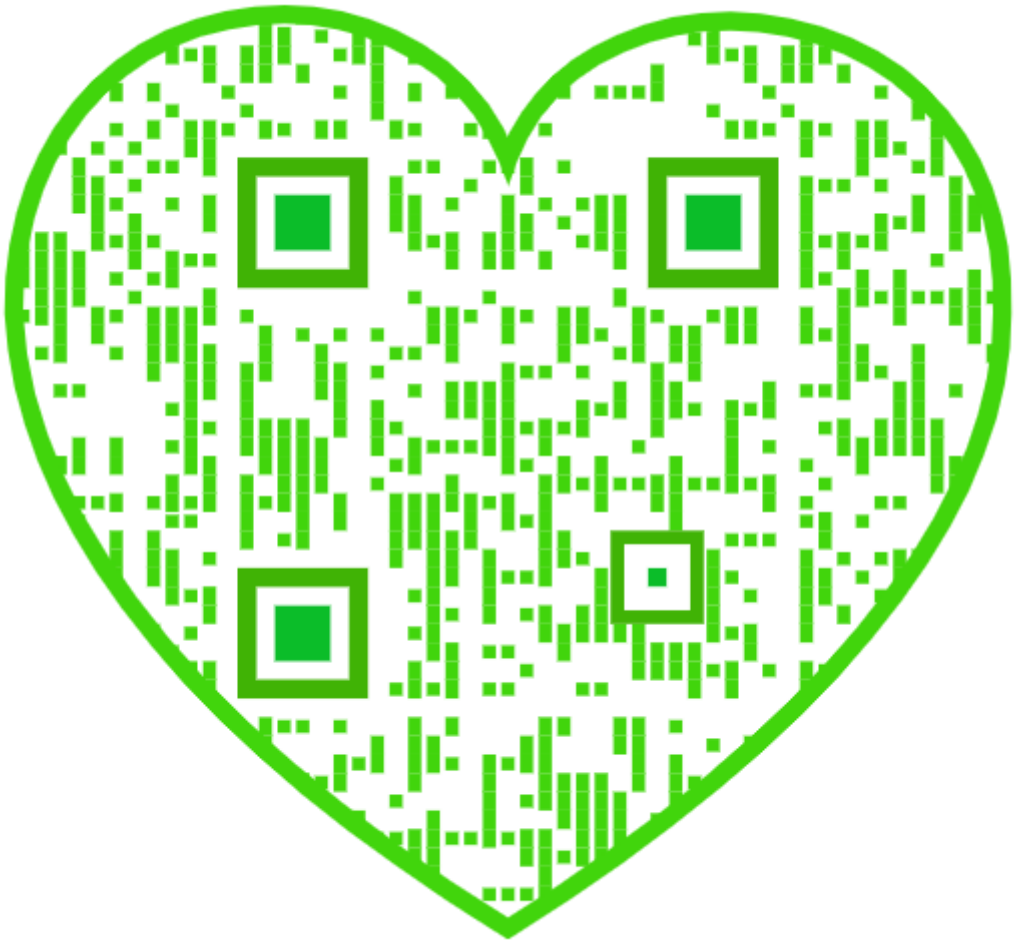

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Water and Sewage Works
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MUNICIPAL AND COUNTY ENGINEERING

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JULY—DECEMBER, 1920

VOLUME LIX

166993
9/11/21

ENGINEERING PUBLISHING COMPANY
INDIANAPOLIS, INDIANA
CHICAGO, ILLINOIS

Municipal and County Engineering

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EDITORIALS

ENGINEERS SPONSOR A POLITICIAN

Engineers, now as never before, are interesting themselves in the political fortunes of men whose success in politics will favorably affect the engineering profession in a material way or will advance causes in which engineers, as a class, are interested. An Illinois case furnishes an interesting example.

Two prominent engineers, of Chicago, have circularized the membership of a Middle Western engineering society on behalf of an Illinois candidate for the United States Senate. The candidate is a promoter of the best type. His engineer sponsors refer to him as "A constructive genius with the rare faculty of securing capital and putting it to work for the good of the people. It is such men who have made possible the practice, promotion and development of the profession to which we belong." In passing let it be said that this view of the promoter comes much closer to the exact truth than statements frequently made by engineers on this subject.

The merits of the candidate are presented to engineers from their own point of view. He is further described as a man who "has constructed many important enterprises, which have furnished employment to thousands of workmen, and given the widest opportunity for the exercise of engineering ability." Throughout, the appeal is to enlightened self-interest as well as to altruism, and it should be effective.

We are glad to see engineers interesting themselves in such matters. Certainly it is better to attempt influencing events than to remain inactive until after the event and then grumble at the turn of affairs. It remains to be seen how far the class interests of engineers will carry them counter to their cherished political faiths and affiliations. But that engineering societies and individual engineers are getting more active in politics is a sign we hail with pure delight, for it is an evidence of the sort of growth which promises so much for the future of the professison.

SUPPORT FOR INLAND WATERWAYS DEVELOPMENT

The platforms of both the Republican and Democratic parties indorse the development of inland waterways and promise actively to promote such development. The construction industry may well rejoice at the prospect thus revealed, for the development of inland waterways will provide a congenial task for the industry and by ultimately relieving rail congestion will quicken constructional activities throughout the country. As long as the traffic is as heavy as at present we see no prospect of the railways meeting successfully the demands made upon them, except by diverting much of the present rail traffic to trucks and waterways, trucks for short haul freight and waterways for some of the long haul freight. Frankly, we do not think the railways can again meet the requirements imposed on them except those requirements be reduced.

We hope engineers will not feel called upon to defend the railways against competition. In fact, the surest way to keep the railways under private ownership, if that is so highly desirable as many think, is to relieve them of their excess burdens. To reach this conclusion one need not pay much attention to the details of railway ownership controversies. The railways simply are not making good. Construction lags and industry falters because of the impotence of the railroads. It is true politicians have sinned against the roads but do not forget this was made possible only by popular support, based on earlier transgressions of the railway managers. So, in arguing the merits of waterway development, we hope the construction industry will keep clear of all considerations pertaining to the roads except the prime one, that they are inadequate and can attain adequacy only through relief.

The most important waterway project now before the country is the St. Lawrence River-Great Lakes project, which will make of the lakes an inland sea, easily reached from the ports of the world. There is a tremendous popular sentiment for this project in the Middle West and the only strong opposition to it, as yet developed, comes from the Port of New York. The greatness of New York is not challenged; every American is proud of that magnificent city, but the Middle West will insist on routing freight through channels which can keep it moving. Fourteen central states favoring the lakes-to-the-sea project will be represented at the Great Lakes-St. Lawrence Tidewater Congress to be held in Detroit, July 22 to 24. Spokesmen for commercial, industrial and agricultural interests will be heard.

The project has such merit that it is bound to be realized in time and it is to be hoped that foredoomed efforts at obstructing its progress will not be attempted. Large scale engineering work will not be required at many points; the engineering work involved at present has to do only with the rectification of 46 miles of the St. Lawrence, between Lake Ontario and Montreal. It is probable this will be accomplished by the construction of four dams to submerge the rapids and to convert the river into a series of lakes. It is estimated the work will cost $150,000,000 and require five years.

STORAGE PLANT FOR ROAD OILS AND BITUMENS MAINTAINED BY STREET DEPARTMENT, WORCESTER, MASS.

By James C. Blake, Commissioner, Street Department, Worcester, Mass.

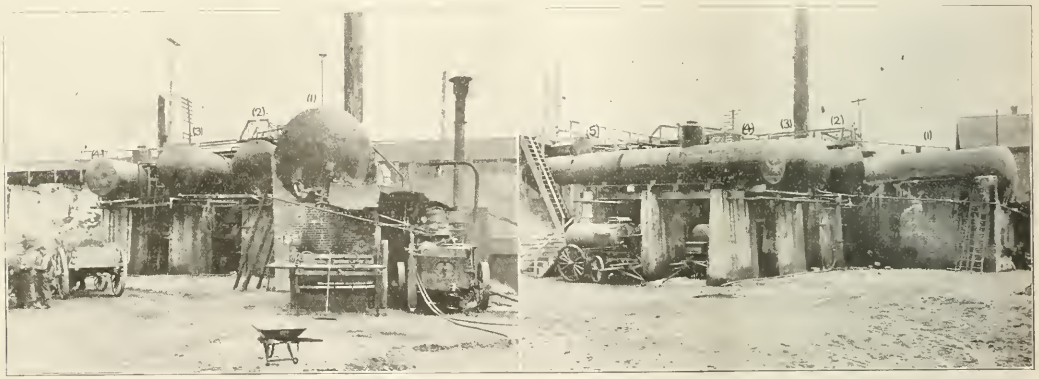
The City of Worcester, Mass., first began the application of heavy tar as a road binder in the year 1907, using at that time a small amount during the season. This increased during the intervening period up to the present time, and in the year 1919, 60,255 gals. were used on the City's streets.

The use of light tars was begun in the year 1914, the amount being 28,808 gals. and its use has steadily increased until in the present year, with the extreme shortage of road oil, in all probability the greatest quantity in the history of the City will be used. In the year 1919, 122,401 gals. were used.

The City first began the use of road oils in the year 1911. It has very consistently stuck to the use of an asphaltic base oil, all of its general practice showing that much better results are obtained by the use of an asphaltic base oil than that of a parafine base. It was the general practice in the City in the early days of the road oiling to use a heavy road oil of from 45 per cent. to 65 per cent. asphalt. At that time many of the streets were sprinkled with water, while a very few were covered with the oil, which was sanded. The use of the water was very destructive to the street surface and experience in the use of the oil developed the fact that great maintenance saving was made in using the road oil in the place of water sprinkling, which was finally discontinued entirely. One of the greatest savings to the City came with the changing to the use of a 25 per cent. asphaltic road oil, thus eliminating the heavy grades of oil which required a larger quantity per square yard of application and also required the use of sand as a covering, although it was found in some cases, which fact could only be gained by experience in the use of the oil, that a light coating of sand applied on certain street surfaces ahead of the application of the oil, formed a material coating and acted decidedly advantageously in holding the street surface. One of the greatest advantages in the use of the light road oil was a slight asphaltic film which accumulated gradually on the top of the street, which proved to be ample to protect the street surface in the heavy summer down-pours, which occurred during thunder storms, and which necessitated thousands of dollars worth of repairs after a storm, previous to the adoption of the use of light road oils as a dust layer. During the war period, this same coating of oil on sand kept the street in perfect condition for two seasons, so that when skipping a street became necessary, the condition was as good as the previous year.

In 1915 the City of Worcester used 606,198 gals. 25 per cent. asphaltic road oil. During the war and immediately following the amount dropped as we were unable to procure it, the 1919 amount being 414,929 gals.

The contract for road oils for the City for the year 1920 called for 600,000 gals. of the 25 per cent. asphaltic road oil. The bids for 45 per cent. and 65 per cent. asphaltic road oil called for simply carload lots, in case of need arising for the use of either of these two grades.



VIEWS OF OIL AND TAR STORAGE TANKS OF STREET DEPARTMENT, WORCESTER, MASS.

Tank No. 1 is 15,000 Gal. Direct Heating Tank for Heavy Bitumens. Tanks 2 and 3 are for Medium and Light Tar and Oils and are equipped with Steam Coils for Heating if used for Medium or Heavy Oils. Tanks 4 and 5 are for Light Road Oils only. Tank 6 is in rear of 2 and 3 and is for Road Oils only. At right of Tank 1, in left view, is shown the Portable Steam Heater used for Heating Cold Patch Composition and for Heating Tanks 2 and 3, and for Heating Cars of Heavy Bitumen set on Trestle for unloading. Section of Trestle shown at left and rear of tanks, where Blocks, Brick and other Road Materials are unloaded and stored.

At the beginning of the use of road oils for sprinkling, the work was contracted. In the year 1914 the City of Worcester undertook the application of all road oils and tars itself. In the year 1914 a distributor was purchased from the Kinney Mfg. Co., of Boston, this being the first automobile distributor which that Company had ever put out. This machine, for the first production of a Company in a new line, was remarkably efficient, and today is in constant use in the City of Worcester, not having as yet been supplanted by any machine in that City for the distribution of the heavier grades of bitumen. Many improvements were made by the workmen of the City of Worcester, some of which were adopted by the Kinney Mfg. Co.

It has been the practice of the city, and I believe that it is the largest city in the East to do so, toconstruct all

of its own highway work and to build and repair a great deal of its different kinds of road machinery. In this connection, two automobile distributing outfits have been built in the city's workshops, these outfits both being primarily for the distribution of the lighter grades of bitumen, either cold tar or road oil, but the heavier machine of the two is also one of the most successful distributors of bitumen which has come to our notice here.

The original storage capacity for the heavy bitumens was a 10,000 gal. tank, equipped with steam coils for many purposes. This was later added to by the acquisition of a second tank, and both were installed at the north end yard of the Street Department, this being the only siding which the City of Worcester had at that time. At this yard the bitumen could be drawn from the tank cars by gravity into the storage tanks, but had to be pumped into the distributors from the storage tanks.

During the course of the grade crossing elimination in the city, the railroad company was allowed to take a portion of the Salem street yard of the Street Department, which bordered on railroad property, and slope off with a dirt fill of the Street Department property. This proved to be a serious oversight on the part of the city officials, as no better siding facilities for Street Department purposes could be found in the city, than this particular location, had a retaining wall been erected at that time and the area belonging to the Street Department been preserved. Later on an attempt was made to obtain siding facilities at this yard, but was turned down by the railroad people, as not being practical of accomplishment. Later on a second attempt was made, which resulted in siding facilities being obtained at this yard. This siding gave a height of better than 20 ft. Between the head of the rail and the yard level below, and under these conditions was very favorable to the construction of tank storage facilities at this point, giving gravity both from the cars into the tanks and from the tanks into the distributors, eliminating all expense of pumping the oils and bitumens.

Upon permission being granted for the construction of the siding, a lease was obtained from the Railroad Company for the very land which had been taken from the city by the railroad, and the construction of a trestle was begun, the entire trestle and all its equipment being constructed by the Street Department forces.

The first installation of tank storage facilities was made with the two 10,000 gal. tanks, Nos. 2 and 3, shown in the accompanying photographs, immediately to the left of the larger direct heating tank, these two tanks being moved from the north end yard and installed in the positions shown. These tanks were equipped with steam coils and could be used either for the storage of the materials so heavy as to require heating before application, or for storage of the lighter road oils, whichever was found necessary. The next installation was that of the two 3500 gal. tanks, one behind the other, Nos. 4 and 5, immediately to the left of the two large 10,000 gal. tanks. These were used entirely for road oils, having no coils. Later, on account of more or less leakage, through expansion and contraction from the steam coils, it was thought wise to construct and install a large 15,000 gal. direct heat tank for the purpose of heating the heaviest bitumens, both tar and asphalt, difficulty being experienced in bringing asphalt to the proper temperature for distribution in bituminous macadam construction, a leakage of the coils causing foaming and difficulty in handling heavy asphalt. This tank has proven very advantageous for the heating of both heavy tars and asphalts, it being found that after the desired temperature is acquired in the tank, which is equipped with the necessary thermometers for showing the temperature of the bitumen in it, that a very slight fire could be operated under the tank and the temperature still maintained at a very constant degree, much more advantageously than with the use of steam.

As will be noted in the photograph, the direct heat tank, No. 1, is simply a large tank erected on the top of a fire box in a boiler-like arrangement with a large stack at the rear and a safety device at the front end of the tank, in case too much pressure is engendered in the heating of the bitumen, to act as a relief valve. There are also installed in the proper locations manholes, through which a man can enter the tank to clean it properly.

The final installation was a 8,000 gal. tank immediately in the rear of the two 10,000 gal. tanks, Nos. 2 and 3, shown in the foreground. It is used primarily for road oils and has no heating device. This complete installation gives the City of Worcester a total capacity of 50,000 gals. storage for light and heavy bitumens and oils. In connection with the steam coils installed in the two 10,000 gal. tanks a portable boiler, shown at the right of the large tank, No. 1, for direct heating, was installed and has since become a permanent fixture, although it is a portable rig. This outfit, as will be noted, is equipped with a tank for maintaining the heat in bitumens which can be drawn from the large tanks and mixed in the proper proportions and maintained at the proper heat for mixing in connection with the patching compounds, the compound being a combination produced from experience from light and heavy bitumens used in general highway construction by the city by the foreman in charge of this particular division of highway work.

As will be noted, proper outlet connections are installed on each tank for the loading of distributing trucks. These outlets are availible to the extent that four outfits may be loading at the same time. In connection with the discharging of the bitumens and oils from the tank cars in which they arrive at the trestle, for the heavy bitumens, such connections are made that an inside steam heating arrangement is contained in the draw pipes connecting with the tank cars. In this way freeze-ups in the discharge pipes from the tank cars are eliminated. The steam heating arrangement is equipped in such a manner that attachments can be made to any cars on the siding for heating previous to unloading, to bring the bitumens to the proper temperature, so that they may be run off into the storage tanks.

In connection with the trestle siding a 4 in. main extends the entire length of the trestle a distance of about 200 ft., which has proper connections at proper intervals so that a tank car may be attached at any point that it is placed on the trestle, connections being made in such a manner that road oils and hot, heavy, bitumen may be unloaded from different cars at the same time.

From this equipment the city has been able to distri-

bute as high as 16,000 gals. of road oil per day and 6,000 to 10,000 gals. of hot, heavy bitumen, it being found entirely unnecessary on account of the quick delivery and on account of the heat which may be obtained in the proper manner from this system as it is equipped, to heat the bitumen in any way in the distribution between the storage tanks and the point of application to which it is sent.

The entire construction of the tank storage shown, except for the brick work under the large direct heating tank, No. 1, was done by the Street Department forces, including the placing of most of the tanks.

METHOD AND COST OF MAKING STADIA SURVEY OF 10,000 ACRE DRAINAGE DISTRICT

By Charles E. DeLeuw, of Kelker, Gates & DeLeuw, Consulting Engineers, Conway Bldg., Chicago, Ill.

A topographical survey of a proposed drainage district along Macoupin Creek in Greene and Jersey Counties, Illinois, was made last winter by parties under the writer's supervision. The methods used in prosecuting the work were somewhat at variance with those ordinarily followed and the writer believes that a brief description of the survey with costs will be of interest to engineers engaged in drainage work.

The land surveyed is bottom land along Macoupin Creek, the bottom varying between ½ mile and 1¼ miles in width. The total length is 20 miles. The shape of the bottom is irregular, there being bluffs of some height and irregularity at the sides and several considerable tributary streams with their secondary bottoms, all of which were covered. There is a timber fringe along all streams and in addition tracts of timber of varying sizes which aggregate approximately one-fifth of the land covered by the survey. The work was done in January and February and good weather conditions obtained throughout. The area of the proposed drainage district is 14,000 acres, but the survey covered only that portion subject to overflow or about 10,000 acres.

The Stadia Method

The stadia method was used in making the survey. Horizontal control was obtained altogether by small triangulations and circuits. A steel tape was used on the first day to check the stadia wires, after which all distances were obtained by rod readings. Hubs were placed from 500 to 1,800 ft. apart by an experienced rodman. This man had no duties other than selection of points for hubs. The distances, vertical angles and azimuths were read forward and backward from each hub, and in case of minor differences the mean was taken. In case of any considerable errors developing the traverses were re-run. Traverses around circuits were plotted daily to check the closure. The allowable error was fixed at three-tenths of one per cent. From each hub sights were taken to locate all land lines, fences, property lines, streams, timber, improvements of all kinds and other topographical features. Elevations of ground were fixed with sufficient accuracy that contours with 1 ft. vertical could be plotted. As topography was taken at the same time that circuits for horizontal control were run, there was no duplication of effort. The stadia party consisted of transitman, recorder and six rodmen. Three 12 ft. and three 14 ft. stadia rods were used. Four hundred and twenty-eight hubs were used in the entire survey, an average of 21 acres being covered at each set-up. The maximum day's work was 400 acres. It should be remembered that there are only about 7½ working hours in the day in mid-winter.

Level and Transit Work

The level party consisted of levelman and one rodman except on cross-section work when an additional rodman was used. Levels were run over a majority of the hubs. In addition to this, the level party established permanent bench marks, took elevations of all high water marks and cross-sectioned the streams at various points. The level party commenced work about February 1st. It did not function continuously and consequently flood conditions obtaining after March 1st hindered the work to some extent and made the cost rather high.

Due to the fact that no bad weather interfered with the transit party, the notes were not reduced in the field, all of that work being done in the office. Reductions were made by means of a large scale graph having horizontal distances as abscissae, vertical differences as ordinates, and an arc of a circle showing degrees and minutes. Reductions of distances and computations of differences between hubs were worked out with six place logarithmic tables.

Cost Data

In considering the following tabulation of costs, it will be noted that most of the rodmen were obtained at a low rate. The costs of the various portions of work were as follows:

Transit Party

Drainage Engineer 13½ days at $10.00	$ 135.00
Transitman 40½ days at $8.00	324.00
Recorder 16 days at $6.00	96.00
Rodmen 41½ days at $4.00	166.00
Rodmen 185 days at $3.50	647.50
Subsistence	153.00
Supplies	31.77
Traveling and other expenses	126.95
Total	$1,680.22

Level Party

Levelman 21½ days at $6.00	$129.00
Rodmen 30 days at $3.50	105.00
Total	$234.00

Reduction of Notes

Drainage Engineer 6 days at $10.00	$ 60.00
Draftsman 8 days at $8.00	64.00
Computer 12½ days at $5.00	62.50
Total	$186.50

Plotting Notes

Drainage Engineer 13 days at $10.00	$130.00
Draftsman 23 days at $8.00	184.00
Computer 3 days at $5.00	15.00
Total	$329.00

Tracing Map

Draftsman 30½ days at $8.00	$244.00
Total	$244.00

Summary

Item	Total Cost, Dollars	Cost per Acre Cents
Transit Party	$1,680.22	16.8
Level Party	234.00	2.3
Reduction of Notes	186.50	1.9
Plotting Notes	329.00	3.3
Tracing Map	244.00	2.4
Total	$2,673.72	26.7

Conclusion

In the writer's opinion, the methods used on this survey produce results which have as much accuracy as is necessary or desirable in work of this character. There is a possible error which might result from the accumulation of minor errors in closing traverses. The details of the topography are correct. From the map, an accurate paper location of new channels can be made with very close estimates of cost. Acreages of various tracts of land subject to overflow and benefits may be computed in the office.

THE CONSTRUCTION OF CRUSHED GRAVEL ROADS IN NEW HAMPSHIRE

By Frederic E. Everett, Commissioner and State Highway Engineer, State House, Concord, New Hampshire.

The using of crushed gravel in New Hampshire was first brought about by necessity. Certain localities had large deposits of excellent gravel, the larger per cent., however, running so coarse that perhaps two-thirds of the metal would be wasted in constructing with a straight gravel specification. To overcome this the crusher was used, first screening the material into various sizes and constructing under a macadam specification. Good results were obtained and time showed that this type of road was giving better wear than the native stone macadam. In general native stone macadam as built in New Hampshire, is made up of all sorts and kinds of stone, some hard, some soft and some medium. As a result a road built of this conglomerate stone wears unevenly.

The crushed gravel is made up of stone that has withstood the wear and grinding glacial action and in most cases is hard and tough, the grade of hardness, of course, varying somewhat in different sections. Experience has shown, however, that stone in a gravel bank will run more evenly than the boulders and stone collected promiscuously. The one disadvantage of constructing crushed gravel roads with a macadam specification, however, is in the necessary wasting of a large amount of the fine material. The sand and fine gravel together with the dust made from crushing will considerably exceed the amount needed in the construction if the crushed material is graded. That the material may all go into the road the screen is removed and the run of the crusher allowed to go into one large bin and construction carried on under a gravel specification.

Method of Construction

Crushed gravel as constructed in New Hampshire is made up of two courses. The sub-grade is prepared in nearly a flat section thoroughly rolled and compacted. Upon this compacted sub-base 6 ins. of run of bank crushed gravel is uniformly spread using dumping board or a spreading machine. This layer is then thoroughly rolled with a steam roller and compacts to about 4 ins. Should soft places develop, due to uneven mixture of the material or too much sand, they are removed and new material added. This course is wet down and flushed so as to insure thorough compaction. (In one case where the road was built in extremely dry weather it was necessary to wet down the gravel as it went into the bin from the crusher to protect the machinery and workmen from the dust. As a result the gravel was thoroughly saturated with water when it went onto the road and was easily compacted requiring no sprinkling or flushing. It was decided, however, that whatever saving was made in rolling and wetting was more than offset in the increased cost in hauling due to the added weight of water.) The second course is laid directly on the first course in a similar manner, and should be of the same thickness although this course can vary if an 8 in. road is not necessary. In the construction it will be found to advantage to carry the two courses along together or as near together as is practicable, as oftentimes there will be some aggregate too coarse for the top layer. If the two courses are being laid at the same time it is an easy matter to confine the coarse aggregate to the bottom layer. Rarely it will be found necessary to spread a layer of fine material from the bank for a finished course, but as a general rule the rolling will bring the fine material to the surface in a quantity sufficient for binding purposes. As soon as the final course has dried out from the flushing and rolling the bituminous material shall be applied. As a general thing from four days to a week is a sufficient time. For a bituminous material both asphalt and tar have been used but for this type of construction it has been found in New Hampshire, from three years' experience, that the tar has been more satisfactory. The tar used is a cold application product and has the following characteristics:

Specific Gravity 1.10 to 1.14.
Specific Viscosity 40 deg. c
High Carbon 8 to 13
Low Carbon 25 to 35.
Total Distillate by weight
High 170 deg. c not more than 5%.
High 270 deg. c not more than 30%.
High 300 deg. c not more than 40%.
Low 170 deg. c not more than 2%.
Low 270 deg. c not more than 25%.
Low 300 deg. c not more than 35%.
Total Bitumen soluble in Carbon Disulphide
High not less than 90%.
Low 95%-100%.

The surface of the finished road is swept, removing all surplus and loose material. On this surface is spread four-tenths of a gallon per square yard of tar using a pressure distributor, spraying one-half the road surface at a time. Upon the applied tar is spread a thin layer of fine gravel, coarse sand or screenings. After this application the road is thrown open for traffic for four or five days or until the bituminous material is thoroughly ironed out, when a second application of tar, two-tenths of a gallon

per square yard is applied in the same manner as the first.

It requires practically 145 cu. yds. of covering per mile of road 16 ft. in width for these two applications. At the beginning of the second season a third application of about ¼ gal. of binder should be applied and covered as before. There is probably 100 miles of crushed gravel road in New Hampshire built in this manner; some sections have been laid as long as 15 years. This type has given such service that at the present time it is one of the three types of surfacing that is being used extensively in New Hampshire, for reconstruction on trunk lines and cross state roads where a better surface than that originally built is needed. There are several cross state roads carrying an extremely heavy traffic, mostly pleasure vehicles, during the summer. The crushed gravel with a tar surface is particularly adapted to this condition.

RHODE ISLAND STATE HIGHWAY DEPARTMENT ADOPTS NEW METHOD OF HANDLING BITUMENS UPON BITUMINOUS MACADAM WORK

By Irving W. Patterson, Chief Engineer, State Board of Public Roads, Room 12, State House, Providence, Rhode Island.

Upon the greater part of the bituminous macadam work laid under the supervision of the State Highway Department of Rhode Island previous to 1920 the bitumen has been furnished the contractors in barrels. The material was heated in kettles upon the job, pumped into distributors and applied. The chief reason for shipping the material in barrels extensively was the fact that asphalts of low penetration have been used exclusively for bituminous macadam construction. Most of the contractors preferred handling the bitumen in barrels because of the difficulty of handling this material successfully from tank cars and also because of the comparatively expensive equipment involved in handling the material from tank cars. It was felt also by many of the contractors to whom contracts were awarded that handling of the material from tank cars very often was not desirable because of the demurrage costs involved by weather conditions unfavorable for applying the material and also the length of time involved in heating and unloading the tank cars under favorable conditions.

A number of petroleum companies have now or are about to establish in Providence terminals for the shipment to New England points of all kinds of petroleum products. Asphalt of course is one of the products stored and shipped from these terminals. The asphalt is stored in large tanks fitted with steam coils so that it can be pumped into tank cars or into barrels for shipment.

The development of the petroleum industry in Providence has made possible the hauling of the material from the storage tanks directly to the greater part of the work under our direction. Handling of asphalt in barrels or in drums of course is a wasteful procedure not only because of the considerable percentage of loss of the material through leakage and in heating in kettles but also because of the cost of the barrels. Our present plan of hauling the material from storage tanks involves of course getting the material delivered hot and it is a question then only of keeping it hot until it reaches the point of delivery.

Our State of course is small and for that reason the material for the greater part of our bituminous macadam work may be hauled from storage tanks directly to the work very economically. There is little waste in this plan and the saving in heating, in the cost of freight and in the cost of barrels as a rule more than compensates for the increased cost of hauling the material in motor truck distributors rather than in cars even for considerable distances.

The greater part of our bituminous macadam work built previous to the present year involved the use of a small distributor designed for handling the material from heating kettles located beside the work. The machine most commonly used is mounted upon a drum rather than upon wheels and is a very efficient machine for doing the work. The drum avoided any possibility of rutting of the stone by the distributor and this we considered very essential in view of the character of the bitumen employed. Although we feel that we can secure no better result by use of motor truck distributors than were secured by the use of the type of distributor used formerly, we are of the opinion that the economy involved in handling the material as we do at present warrants a continuation of its use.

THE EVILS OF UNDERESTIMATING CONSTRUCTION COSTS

By William E. Skinner, Consulting Engineer, 542 Lumber Exchange Bldg., Minneapolis, Minn.

One of the greatest evils that municipalities, private corporations and individuals have to contend with is underestimating on proposed new construction work or repairs to old works.

Four Causes of Underestimating

There appear to be four causes for underestimating which will be taken up in the reverse order of their importance. These are fluctuation of prices, carelessness in the preparation of estimates, lack of knowledge as to the actual cost of doing the work, and deliberate attempts to get the work started by means of a low estimate, knowing that the party furnishing the money will in almost every case be able to secure the needed funds to complete it no matter how inconvenient, or, in many cases, how detrimental this will be to the final success of the project.

Some one will say "Oh yes! it is all right to say that underestimating causes trouble, but the way prices have been fluctuating for the past two or three years it has been impossible to make estimates that can be relied upon." This is granted, but these have been unusual conditions that do not have to be contended with ordinarily.

That is not the kind of underestimating that is contemplated in this article, but even with the adverse conditions obtaining, the architect, consulting engineer or other advisor, if he were in touch with conditions as he should be, could at least partially overcome this difficulty by making allowance for a probable price increase and

also by making a larger "incidentals not otherwise accounted for" item in the estimate.

Business conditions, however, will in all probability become stable in the not distant future and this first reason for underestimating will not be of sufficient importance to take up more space in this article.

Careless Estimating

Carelessness in making up estimates is inexcusable but frequently an estimator who is perfectly familiar with prices, conditions, etc., will, on account of being overloaded with work, "jump" at his costs or, in other words, will not take the time really to estimate what the work will cost. When this is done it not infrequently occurs that some item of importance is overlooked or omitted and as a consequence his estimate is low.

Many times where the estimator is perfectly capable and has more work than he can do, younger and inexperienced men are given the detail work and it is supposed to be checked by the man in charge. If he is careless or inclined to be slack there is a chance that underestimating will occur through the lack of knowledge of the man making up the figures and the failure of his superior to go far enough into the detail to know that it is correct instead of taking it for granted "that he has had enough experience by this time and I will not need to waste the time checking him up."

This phase of underestimating can only be overcome by finding some method that will put the careless estimator in a position where he will not dare to be careless.

Ignorance of Costs

Lack of knowledge is the cause of underestimating more frequently than any other one thing. Take, for instance, the case of a small town wishing to install an electric light plant. The council or village board are all men serving the community without compensation or, if any, a very small stipend. Each man has his own business to look after and in most cases is kept busy all the time in doing so.

When the proposition is first broached the chances are that there is not a single man on the board who has the slightest idea as to just how to proceed in the matter. Perhaps one of them knows some man in some branch of the business, perhaps a lineman for some large corporation. He is written to in reference to the matter and seeing an opportunity to better himself as it appears to him he tells them that he will leave his present position and lay out and build the plant for them. The board not knowing the details of the work that he has been doing or the requirements for a man to design and install a plant, select him for the position.

This man in question may have been a first class lineman, engineer, bookkeeper or other employe of some electrical firm, but there may be many phases of the situation that are unfamiliar to him and he is not in position to design and install this plant for them. The first move that this man makes is to get in touch with some friend who is in the business, usually the representative of some manufacturer or jobbing house, explain his case, and ask for help. The salesman, seeing a chance to get inside information and perhaps sell a job without competition, very readily agrees to help him. This salesman, probably not being an engineer or not having had experience enough to supply the needed information, takes the matter up with his house and the best man in the company will lay out what appears to him from the information furnished to be the best plan for the station. In many cases these plans are as good as would have been made by a consulting engineer but in some cases the salesman uses the opportunity to "make a sale" regardless of what the requirements are.

There are many cases where the plant installed as described works out all right but almost invariably the first estimate is over run and more money has to be raised for the project. In some cases the plants are not suitable for the work that they have to do and it becomes necessary to scrap them in a very few years.

A plant which came under the writer's notice a few years ago was installed under circumstances where the situation was largely dominated by a salesman for a threshing machine company, who insisted that the plant be installed with exceptionally long belts because "more power can be obtained from an engine with a very long belt." The belt centers have been reduced but even yet they are more than 50 ft. on a 125 kw unit. At the time a new unit was installed about ten years ago they could have changed from direct to alternating current for a comparatively small sum. This was not done however and they will shortly, be obliged to spend about $75,000 for a new plant.

Consulting Engineers

On Jan. 1, 1920, there were only three States in the union that had a license law to compel men desiring to become consulting engineers to register, take an examination or become responsible to the state in any way whatsoever. In almost any other line of business a man has to serve an apprenticeship, take special training, have a college degree, or in some way fit himself for the work undertaken. To become a consulting engineer, apparently all that is necessary is to have enough money to have stationery printed and gall enough to tackle the job. This does not mean all consulting engineers for there is a class of men who fit themselves for the work and who are absolutely reliable in every way.

A man who has had only the technical education should not be permitted to practice until he has had practical experience as well for in many cases what looks the best on paper may not work out in practice. Someone has to pay for this practical experience and it should not be the customer who has employed him with the understanding that he is an expert in his line. Not infrequently in power plant work a building is made ready to receive the machinery and when the apparatus is received it is found that the side of the building must be opened in order to get it inside.

Intentional Underestimating

The consulting engineer who deliberately misleads his customer by underestimating in order that the work will not appear so expensive that it can not be proceeded with should be put in the same class as any other individual who misrepresents his goods. A case in point is the case of a city where the consulting engineer estimated the cost of a sewer and water system at $56,000. When the council had passed accounts totalling something over $100,000, the mayor asked the engineer why he told them that the cost would be $56,000. Was it because he did not know,

had he made some bad mistake, or just what was the reason? The engineer shrugged his shoulders and said: "If I had told you that it would cost more than $100,000 you would never have started it." This man should have been deprived of any chance to continue in engineering work and should have been given the same sentence that any other man would receive who deliberately defrauded someone out of money.

Another case in point is where an estimate had been made of the cost of a water power development. When the engineer's report was given to the proper authorities and they had looked it over they told him that if he would reduce his estimate by 25 per cent. that he would be given the work. His reply was: "Did you employ me to tell you what I believed this work would cost, and I know from past experience that the figures are conservative but within a reasonable per cent. of the exact cost, or did you employ me to come here and tell you what you thought the work would cost? My estimates were made to give you the information that you require and they will have to stand." This engineer was hardly out of the city until another one came along and he was shown the first engineer's figures and asked if he did not think that the figures in question were at least 25 per cent. high. He assured them that he did and was willing to make up plans and specifications on that basis. Constructing the plant proved that the former engineer's estimate was approximately 2 per cent. above actual cost and the city was compelled to call a special election to vote more money to complete the work.

Suggested Remedy for Evil of Underestimating

Enough cases of this kind could be cited to fill a book. Destructive criticism is worse than no criticism at all and unless a remedy can be suggested it is better that the matter be left alone. A suggestion as to a possible remedy for the evil of underestimating is given herewith in the hopes that it may in some small measure lead to some solution of this problem that will make the engineering profession one that can be looked to as one of the most respected of all professions and that when it is said that this estimate was made by a consulting engineer, the figures will not be questioned as to their accuracy and reliability.

A uniform state law should be adopted by the different states licensing consulting engineers, architects and all others in similar positions who prepare estimates of cost of certain improvements, betterments, new work etc. This law should be administered by a commission, free from politics, with examining boards in each branch to be covered, the members of which should be men of recognized ability and experience in their line. Before a certificate is granted allowing a man to practice he should be compelled to furnish a bond guaranteeing the correctness of his estimates and his responsibility in connection with the work. When this is done a schedule of charges or fees should be made covering insofar as possible standard classes of work.

It is further suggested, although this would have to be worked out in detail, that the engineer, architect or other person making estimates for the purpose of guiding a client in the expenditure of his money for any purpose, be allowed a certain percentage, say 10 per cent. over his estimate above which the expenditure should not go. If when the work is let this amount is exceeded he should lose his fee in proportion to the extra cost until it was exhausted. After reaching the point where his fee is exhausted he should become personally liable for the excess over the amounts as above allowed.

One possible situation that might arise that would require a modification would be where the consulting engineer had for some reason, whether just or otherwise, incurred the enmity of the contractors in his locality and they decided to put him out of business by pooling and making all bids much higher than his estimate. The engineer should have the opportunity of submitting his estimate to an arbitration board whose duty would be to check the prices and if his estimates were ample the penalty should not be imposed.

If a better solution of this problem is available it would be to the best interests of all concerned to adopt it, for the tendency to underestimate from reasons above given, or from others not mentioned, does not seem to be appreciably decreasing.

As an illustration of the fallacy of the argument that underestimating can not be eliminated one can cite the case of a consulting engineer who has been in business for 15 years and has a record of only two cases where his estimates were low, one of them 5 per cent. which caused him to make the resolution always to make his estimates ample, and the other where the prices on the material increased 30 per cent. from the time the estimate was made until bids were received.

DELAWARE WILL BUILD 40 MILES OF HIGHWAYS WITH BITUMINOUS FOUNDATION AND ASPHALT WEARING SURFACE

By Charles M. Upham, Chief Engineer, Delaware State Highway Department, Dover, Delaware.

At a conference held, June 21, 1920, with the Chairman of the Delaware State Highway Department, it was decided that it would be very inopportune to retard the procedure of the 1920 highway construction program.

The original program for the year consisted of approximately 80 miles of concrete highway. Only about half of this has been placed under construction. After carefully considering the present situation, it seemed somewhat doubtful about placing any more concrete highways under construction on account of the lack of cement shipments. No difficulty has been experienced in securing asphalt and stone shipments. Therefore, it was agreed that the program should not be held up, but that the highway should consist of a bituminous foundation and an asphalt wearing surface. Plans are now being completed and proposals will be called for some time about the middle of August. There will be approximately 40 miles of road in this experiment.

A smaller experiment consisting of approximately 15 miles of asphalt surface road was tried out in Sussex County, Delaware, and the results proved very gratifying to the users of these highways.

It was hoped that the main system of the State could be constructed of concrete or concrete foundation, but the demand for the completed roads and the condition of cement shipments have made it necessary to consider asphalt construction.

TREE PLANTING IN THE CITY OF ST. PAUL, MINNESOTA

By J. E. Carroll, Mem. Am. Soc. C. E., Superintendent, Bureau of Construction and Repair Department of Public Works, City Hall, St. Paul, Minn.

Tree planting in the streets of St. Paul is now done through the Department of Public Works like any other local improvement. Usually a petition is presented to the Council, the same as for any other improvement, and a time is set for all those who may be interested to come in and be heard in the matter, at which time the Council may or may not order the improvement. Invariably, in the case of tree planting, the work is ordered done.

New Activity for Department of Public Works

This is a new activity for this department and differs from the former custom, that has prevailed here for many years, in which the property owners were allowed individually to plant their own trees as they saw fit. The former method resulted in lack of uniformity in the variety of trees, irregularity in distance apart and, in many cases, in the selection of trees of inferior quality and poor variety. Under the new method the Department has the expert services of E. L. Finney, City Forester, to guide it in all matters where a tree specialist is needed. The result is that the right kinds of trees are selected and the work is done properly and also with a view to saving money for the property owners concerned. Promiscuous tree planting on streets has now become a thing of the past. Although the city is far behind in tree planting in its residence sections, the program for the next few years insures proper care for the newer districts.

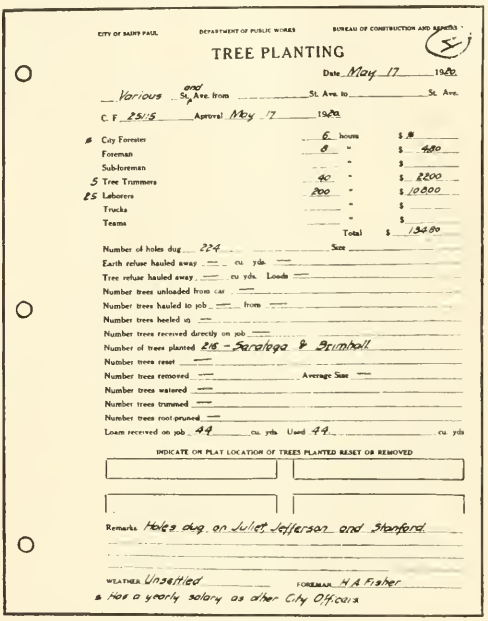
Cost of Planting

The cost of planting trees is paid for by an assessment against the property benefitted and on various small jobs put in during the past season the cost has varied from 10 cts. to 15 cts. per foot of frontage for trees 10 ft. to 12 ft. high of 2 ins. to 2½ ins. in diameter, including, of course, all labor and the necessary black loam in setting the trees. The trees are set approximately 40 ft. apart in the center of the boulevard, and are for the most part elms. An attempt is being made to get lindens, hack-berry, ash and pin oak. At present the market is very short on trees other than elms and it may be that the Park Department of this city may have to provide in some manner, for the growing of suitable shade trees of the varieties above mentioned in order to supply such trees at a reasonable cost.

St. Paul ranks close to the top among cities of its class in the matter of shade trees and has done remarkably well when consideration is given to the conditions under which it has worked and planted trees. The citizens have had to deal usually with people who have wanted to sell them as many trees as they could of a quick-growing habit, such as box-elder, soft maple, cottonwoods or poplars. Hence, on looking over the streets on which shade trees were put in in former years, it cannot be denied that much credit is due to the people in selecting so many elms and other trees of good quality.

Tree Maintenance

The maintenance of trees in proper condition, such as providing sufficient head room where branches project over walks, or roadways, barricading, trimming and protection from decay and other preventable causes, is placed by an ordinance under the Department of Parks and the work is directly in charge of the City Forester, which work is done upon order of the Commissioner of Parks without petition from the property owners. The cost of maintenance is paid for by assessment against the abutting property on the street where the work is done and amounts to about 3 cts. per front foot every three years. Regular tree trimming crews work about ten months out of every year. For the purpose of taking care of the payrolls a Forestry Revolving Fund, now amounting to about $20,000, is used to defray the expense. When the assessment is collected the revolving fund is reimbursed.



CITY OF SAINT PAUL — DEPARTMENT OF PUBLIC WORKS — BUREAU OF CONSTRUCTION AND REPAIRS

TREE PLANTING

Date May 17 1920.

Various and St. Ave. from ____ St. Ave. to ____ St. Ave.

C. F. 25/5 Aproval May 17 1920.

#	City Forester	6	hours	$ #
	Foreman	8	"	$ 4.00
	Sub-foreman		"	$
5	Tree Trimmers	40	"	$ 8.00
25	Laborers	200	"	$ 10.00
	Trucks		"	$
	Teams		"	$
			Total	$ 13.80

Number of holes dug 224 Size ____

Earth refuse hauled away — cu. yds.

Tree refuse hauled away — cu. yds. Loads —

Number trees unloaded from car —

Number trees hauled to job — from —

Number trees heeled in —

Number trees received directly on job —

Number of trees planted 28 - Saratoga & Grimball

Number trees reset —

Number trees removed — Average Size —

Number trees watered —

Number trees trimmed —

Number trees root-pruned —

Loam received on job 44 cu. yds. Used 44 cu. yds

INDICATE ON PLAT LOCATION OF TREES PLANTED RESET OR REMOVED

Remarks Holes dug on Juliet Jefferson and Stanford

WEATHER Unsettled FOREMAN H. A. Fisher

Not a yearly salary as other City Officials

TYPICAL DAILY FIELD REPORT OF FOREMAN OF TREE PLANTING IN ST. PAUL, MINN.

Thirty-five thousand trees in the residence districts have been thus taken care of since 1914.

Procedure of Property Owners

When a property owner desires to plant, trim or remove trees, he must first secure a permit from the Department of Parks and the work is then supervised by the City Forester. Where existing trees have to be trimmed or cut on account of the removal of buildings, the stringing or removal of wires and the laying of sewers, water mains or conduits, the work of trimming or cutting the trees can be done only by the crews working under the direction of the City Forester. The expenses in such cases are generally borne by the holder of the permit.

While some misunderstanding was in evidence at first concerning the scope of the Forestry work, it can safely be said that the people have come to rely on the Park Department through the City Forester not only to protect the trees, but to furnish information helpful to those who

request it. We believe that our method of maintenance is the most economical and practical way of caring for trees uniformly. The hearty cooperation from the people is very evident, and as a result the present method of maintenance has become firmly established in the city of St. Paul.

Additional Cost Data

Last year the department planted about 3500 trees. This year we expect to put in at least 7000. The trees are from 10 to 12 ft. high and from 2 to 2½ ins. in diameter. The trees last year cost about $1.10 each; this year we are paying up to $1.25. Black loam costs from $2 to $3 per cubic yard, depending on the length of haul. In isolated cases we get the dirt as cheap as 50 cts. per cubic yard, first cost, and move it ourselves to the place where needed. In estimating the cost of doing this work we figure that one man in 8 hours should dig at least 10 holes and one man should plant 20 trees in an 8-hour day. A representative copy of the daily field report submitted each morning for the work of the previous day is shown herewith.

For the purpose of providing for the expense of replacing dead trees within two years after planting, it is proposed to get authority by an ordinance (to be passed by the Council) to charge against each job an amount of money equivalent to not more than 3 per cent. of the total cost of the work, which money will be placed in a fund known as the Force Account Tree Planting Maintenance Fund. Our experience to date leads us to believe that a maximum charge of 3 per cent. of the cost of each job will be ample; yet should it develop later that such amounts are not sufficient to provide ample funds to make replacements, then the ordinance creating the Fund can be amended accordingly.

ELEVATED RAILWAY VS. SUBWAY IN PHILADELPHIA

By Walter F. Ballinger, of Ballinger & Perrot, Architects, Engineers and Constructors, 329 S. Broad St., Philadelphia, Pa.

For the past seven or eight years Philadelphia has been actively struggling with its local passenger transportation problem, its needs and requirements having outgrown the capacity of the present facilities.

During the Blankenburg administration a Department of City Transit was created with ample appropriations for investigation, surveys and expert engineering services for the solution of the problems. The work was most comprehensive and thorough, their principal recommendations being a subway on Broad Street from the Navy Yard south to Luzerne Street on the north, a distance of 8 miles, where it emerged and divided forming a Y as two elevated railways.

This subway also had a loop around the congested or principal retail store section on Arch Street, Eighth Street and Locust Street. Another feature was an elevated railway connecting with the present system at Delaware Avenue and extending to Frankford in the northeast section of the city. This latter line has been built but is not yet in operation.

Considerable work has been done under City Hall in connection with the retail store loop, but otherwise the Broad Street subway has not been physically commenced. Estimates made in the year 1915 showed the cost of the Broad Street Subway to be $25,000,000 and the retail store loop to be $7,000,000. Legislation was enacted authorizing the city to spend the money and arrangements were made for bond issues to cover the cost. Before many of the contracts were entered into, however, the war came on. Work was suspended and in the meantime costs have increased to approximately two and one-half times what they were before the war, so that it is not possible to carry out the original scheme, including subway, with the money available.

In the meantime I understand that the idea of the loop around the retail district has been abandoned. This was one of the controlling reasons when the plans were made for recommending a subway, as an elevated loop would be objectionable on the present streets, and to widen them would be prohibitive in cost.

I understand that the ordinary steel elevated railway costs about one quarter as much per mile as a subway, and that an elevated railway of superior construction, to be made handsome and noiseless, would cost about one half as much per mile as a subway. There is, however, just as much need for wider streets and improved surface traffic conditions as there is for high speed transit, and sooner or later our streets will have to be widened or new streets constructed, or else some of our present streets will have to be double decked.

The principal objections to an elevated railway are the noise and the shading of buildings. Noise can be prevented by proper construction and equipment, and the shading of buildings can be prevented by placing the elevated railway in the middle of a sufficiently wide street.

My suggestion is that a new boulevard be provided from League Island to Tabor, preferably about Eighth Street, widening Eighth Street eastward to a width of 200 ft. I suggest Eight Street because this would miss the Philadelphia & Reading Railway terminal at Twelfth Street and its elevated line at Ninth Street, as well as missing the Pennsylvania Railway. Any other street found more desirable would do as well or, instead of widening a street, a new street could be provided in the center of an existing block, making the boulevard at the backs of the present houses.

In the center of the boulevard locate a four track elevated railway, built of steel and reinforced concrete. This would be approximately 50 ft. wide and would leave 75 ft. on either side. Taking 15 ft. of this for a sidewalk, the remaining 60 ft. of roadway could have a 25 ft. Belgian block pavement next to the curb for slow moving traffic, three vehicles wide, then allow 10 ft. for street car traffic and the remaining 25 ft. for fast moving traffic.

The elevated railway should be constructed so as to constitute a waterproof roof 10 miles long and 50 ft. wide. Enclosures could be made between the columns on the sides, where necessary, to house Markets, Police Stations, Fire Houses, Public Libraries, Bath Houses, Community Houses, Garages and Parking Spaces, Museums, Public Comfort Stations, and open spaces merely fenced in for Children's Playgrounds. These

various features could be repeated every mile or so, as might be needed.

It is much more pleasant traveling on an elevated railway than in a subway and there is not the problem of ventilation to overcome. People like to ride on an elevated railway and look out over the city; no one will ride in a subway excepting to "get there." So many things could be accomplished with approximately the same expenditure of money, the saving in the cost of an elevated railway as compared with a subway would go a great way toward paying for the land damages to acquire the wider boulevard. This boulevard would accomplish several results:

First: A most satisfactory automobile route for passenger cars between the City and the suburbs.

Second: Slow moving business vehicles which now block street traffic on nearby streets would seek this roadway which would be unobstructed, and thus allow better time to be made by the street cars going north and south for several blocks on each side of it.

Third: The putting of some of the public utilities under this roof would be a great convenience and would save considerable expense in providing for them in other locations.

Fourth: It would aid the market problem and would permit the producer and consumer to meet and thus reduce the high cost of living.

Fifth: It would make for health, cleanliness and convenience, and

Sixth: It would add to the value of real estate on either side of this boulevard, so that the resulting taxation would in time pay for the improvements.

If, however, the City had the power of Excess Condemnation, as is the case in some European cities, by acquiring the property on either side of the proposed boulevard and reselling it, the entire expense would be paid for without cost to the tax payers. The latter method could not be done, however, without legislation and, perhaps, Constitutional provision, and this should be brought to the attention of all proper officials to submit a draft to the proposed Constitutional Convention.

I have submited this scheme to Director Twining of the Department of Transit of the City of Philadelphia and I understand it is favored by him.

COMMENT ON THE TREND IN BRICK PAVEMENT CONSTRUCTION

By T. R. Agg, Professor of Highway Engineering, Iowa State College, Ames, Iowa.

It is not so long since the standard brick pavement consisted of a 4-in. base of 1:3:6 concrete, a sand cushion 1½-ins. thick and a wearing course of 4-in. brick grouted with 1:2 mortar or filled with a bituminous material. Indeed sand-filled brick pavements were common within a few years.

Then high speed traffic developed and the demand for greater smoothness resulted in refinements in construction methods and particularly in the gradual increase in the use of the grout filler. Then motor truck traffic began to be a factor in that heavier loads and greater impact were introduced into the problem, and engineers began to use other than the sand bedding course, and to increase the thickness of base.

About that time some officials began to doubt the necessity of the 4-in. wearing course on such heavy base courses and the vertical fibre and the 3-in. wire cut lug brick were introduced.

After several years of heterogeneous design practice has settled down to a few fairly well defined types of brick pavement.

Sand Cushion Pavement.

A very large yardage of brick pavement is still being constructed of the old type in which a sand bedding course is employed with either a grout filler or a bituminous filler. For small cities and for towns this is probably an entirely satisfactory type and its use will likely continue for some years to come. In this type both 4-in. and 3-in. brick are employed and the lug brick and the vertical fibre brick both with lugs and without lugs are all widely employed. In fact the demand for brick at this time is so great that any type of brick with the requisite durability will find a ready market.

Semi-Monolithic

The investigations of Mr. Schuyler in St. Louis and similar investigations less extensive in scope in various other places drected attention to the tendency of the sand cushion to shift under the brick surface, particularly the grout-filled surface. This led to the suggestion that a lean cement mortar bedding course be substituted for the sraight sand bedding course. This type has steadily gained in favor for roads subjected to motor truck traffic and for streets subjected to a large volume of trucking. Either the bituminous or the cement grout filler is employed and brick of all types are employed. Probably the favorite design is the 5-in. base, with a 1-in. bedding course of 1 to 4 mortar and a wearing course of 3-in. brick and a bituminous filler.

Monolithic Brick Pavements

In 1913 and 1914 Mr. Parrish began experimenting with a system of construction where the brick were laid directly on the green concrete base. The first work was carried out near Paris, Illinois, but about the same time the Pennsylvania Railroad laid some of the same type in connection with the great Pennsylvania terminal in New York City. After some experimenting a method was perfected whereby this method could be employed with entire satisfaction on rural highway construction, but it has not been adopted very widely in city practice. In this method the bedding course consists of a layer of dry cement-sand mortar ¼-in. thick spread on top of the green concrete base. To get the requisite smoothness the base and bedding course must be struck off very carefully with a special metal strike board and herein lies the principal difficulty in employing the method for pavements of greater width than about 20 ft.

The cement grout filler is employed exclusively for this type of construction and no expansion joints are provided. There does not seem to be a valid reason why the bituminous filler could not be used if expansion joints were provided in the base. Some difficulty has been experienced with blow-ups in the monolithic pavement but recent inquiries in a number of states that have a large mileage of this type of pavement seem to indicate that

those most familiar with the pavement do not consider the relatively few blow-ups to be a serious defect.

The recent adoption by the brick manufacturers of the lugless brick as the standard paver has excited no little discussion and engineers are by no means agreed that it has been a wise move. It is pointed out that a very large yardage of such brick have been laid in recent years but that may only indicate vigorous promotion. The behaviour of the pavements laid with this type of brick will be watched with interest.

Some attention has also been directed to the use of the bituminous base for brick pavements as well as for sheet pavements, but for some reason the idea has never taken well. Some test pavements with that type of base would supply much needed data.

Generally speaking, the trend in rural highway construction is toward better concrete and greater thickness for the base, and more rigid requirements for all of the materials entering into the pavement. Requirements for quality and workmanship with brick pavements are also more exacting than a few years ago. This is because of the necessity for securing pavements that are smooth when completed and that will stay smooth. Motor traffic has forced these refinements.

The foregoing paper by Professor Agg was read before the Section on Municipal Engineering of the Iowa Engineering Society at its annual meeting held in Fort Dodge, Iowa, Feb. 18, 1920.

NECESSARY STEPS IN COMPREHENSIVE STREET DEVELOPMENT PROGRAM

By James W. Routh, Director, Rochester Bureau of Municipal Research, Inc., Rochester, N. Y.

The present article suggests steps believed necessary in the preparation of a comprehensive street development program involving paving and repaving streets, extending sewers, water mains and other utilities and by developing boulevard systems to provide convenient access to parks.

Means of Approach

There are two ways in which this problem may be approached. The most obvious way, and the way in which similar problems generally have been approached in the past, would be simply to list the streets in need of paving and repaving and to decide arbitrarily on the type of pavement surface to be provided in each case. The pavements then would be constructed according to general local practice, probably with a single standard of construction throughout and for all streets. Only the type of surface might vary from one street to another, and that but little. The paving program would consist then only of this list of streets arranged in the tentative order in which the work would be done. Such a program would be simple to prepare, uneconomical to follow and inadequate to meet the needs of the city.

The preferred way of handling the problem would be to base the program on a scientific study of conditions to be met; to design each pavement as a structure suitable to serve economically the purpose for which it is intended, and to develop the street system not as chance has made it but as utility would direct.

The street system is the most important of the city's transportation facilities. Especially where motor trucking plays a particularly important part in handling both the incoming materials and the outgoing products of local industry, the street system should be developed to meet the needs of industry, as well as the general public, in the most suitable and economic way. Important factors to consider are the shortness of routes between local shipping points, and the ability of pavements built on such routes to stand up under the traffic conditions imposed upon them. Both factors may be sub-divided, and both require careful scientific analysis and study.

The Layout of the Street System

It seems trite to state that the purpose of a street system is to provide ready means of transportation and communication between different points in the city, as well as entrance to the city from the surrounding country. But the layout of most street systems plainly indicates that little thought was given this purpose in the original platting of the streets. Moreover, the purpose includes, by inference at least, not only that the direction of the main streets shall be such as to provide the shortest possible routes between any two given points of importance, but that the routes so provided shall be passable and attractive to traffic. This means that layout and type of construction must be considered together.

In order that the purpose of the street system may be fulfilled it is essential that the points between which short, direct, passable routes are required shall be known. This information can be had in two ways. If the street system is to be laid out in undeveloped territory, as in a new city or town, the furture location of important industrial, commercial and social centers can arbitrarily be decided upon in advance. But if the street system is to be developed to meet the needs of an older and well built up territory, the actual location of established industrial, commercial and social centers must be determined and the street system improved and developed in accordance therewith.

Cost of Local Transportation

To the business man the cost of local transportation by team or motor truck is a considerable item both for incoming materials and outgoing products. This cost of motor trucking will range from 10 to 15 cts. per ton-mile on well paved streets to 30 to 35 cts. per ton-mile on unpaved or poorly maintained streets. If long detours are necessary because of poor pavements or traffic congestion or lack of direct routes, the cost mounts in proportion. Drivers of motor trucks will go considerable distances out of their way to avoid rough pavements or unpaved streets. Any delays caused by traffic blocks, or slackening of speed below the normal because of poor pavements, directly affect the cost of transportation. Therefore, apart from the matter of convenience, it is a matter of dollars and cents to a city's industry to provide direct passable routes between local shipping points.

The solution of this problem means the laying out of a system of main and intermediate thoroughfares in accordance not always with present traffic channels, but with the location of what may be called local terminals. Traffic will follow the shortest route if that route is made attractive by being smoothly and substantially paved and by being

kept free from traffic obstructions and holdups which occur on narrow, poorly designed streets. Moreover, much expense for snow removal in winter can be avoided and traffic will be more adequately cared for by concentrating attention upon a comparatively few main thoroughfares instead of attempting to keep all streets open at all times.

Zoning Restrictions

Another thought enters here, and that is the importance of controlling the direction of the future industrial growth of a city. It is costly enough to design and construct a system of thoroughfares to meet existing conditions without contemplating the possibility of unregulated industrial building making necessary changes in the system within the next few years. A mile of asphalt pavement 50 ft. in width would cost, on a pre-war basis, about $59,000. No more of such pavements than are absolutely necessary should be built. The existence of a well laid out street system will, in itself, tend to direct industrial growth as it should go, but it is wiser to provide governmental regulation of building (zoning restrictions) than to chance the future without such control. Hence the problem of zoning is closely related to the problem of street layout. Much the same physical data must be considered in both problems, and the fitness of the solution of each is dependent upon the other. Both must recognize not only the present location of industries but also peculiar advantages of site, such as convenience of rail and water transportation facilities, which will tend to attract future industrial development in certain directions.

In this connection it should be held in mind that the development of a system of main thoroughfares, including the widening, straightening and paving of existing streets, would greatly increase the value of property abutting on such thoroughfares. This increase in property value and utility would be enhanced still more by proper zoning and building regulation.

Street Design

Without going deeply into details, it is believed that certain elements entering into street design should be held in mind in order that the relation between layout and design may be evident.

Almost anyone can "design" a pavement according to so-called "standards." Such "design," however, hardly warrants the naming. It is guess work, pure and simple, and is responsible for much unnecessary expenditure of money both in original construction and in continual maintenance. Highway engineering may not be an exact science, but at least it should approach the scientific. It is not scientific to build the same kind of pavement on residential, business and industrial streets, as is done in many cities. A pavement is not merely a wearing surface. The wearing surface takes the wear, wears out, and must be replaced.

If the pavement itself has been designed properly and constructed carefully, it should be possible to resurface it repeatedly without rebuilding the entire structure. Who would consider a bridge properly designed and built if the useful life were only the life of its floor.

Influence of Traffic on Design

Pavements must be designed in accordance with the traffic, or rather in accordance with the local weights, they have to bear. Therefore, it is necessary to know these loads weights, and they can be determined only through knowledge of the kind of vehicles and the weight of the loads to be hauled over the pavements. For purposes of structual design it is not so necessary to know the exact annual tonnage to be hauled over a pavement as it is to know the maximum live load weights to be hauled over it and the frequency with which such loads must be borne. The pavement should be designed for this maximum weight and intensity of traffic, to withstand impact and with an adequate factor of safety.

The width of a street also must be regulated according to the amount and kind of traffic to be borne. It frequently is found that some of the heaviest traffic streets are altogether too narrow for best utility. Moreover, some of these streets rightfully should not carry such heavy traffic because they do not provide the shortest and most direct routes between shipping points. This condition can be corrected by ascertaining the location of these shipping points and by laying out a system of heavy traffic thoroughfares to serve them. It would be an ill-advised expenditure of money to pave or repave, or even to resurface, all streets now bearing heavy traffic with the idea that they will continue to carry it, without first studying their location in relation to local terminal points. It also would be ill-advised to improve streets which are too narrow for heavy traffic if they properly are main thoroughfares, without first widening the paved area sufficiently to carry that traffic easily and without congestion.

Another factor to be considered in designing pavement widths is the need for parking space for automobiles and other vehicles. It is believed, however, that the parking problem is partly one of police control. Proper design of the street system should provide parking space, preferably on streets adjacent to main thoroughfares, and suitable ordinances and police control should ensure its proper use.

Regulating Traffic

At this point it is desired to digress slightly from the subject of pavement design to emphasize the importance of proper regulatory laws and police control over the use of streets.

As stated in the foregoing, a main thoroughfare must be designed for heavy load weights, for intensity of heavy traffic and for impact from heavy loads. It would not be economical to design and build all pavements within the city to withstand the effects of unusually heavy loads being hauled over them. The point may be made that if this is true, residential and other light traffic streets must be in danger of destruction whenever heavy loads of building materials, coal or machinery are hauled over them. To a certain extent this is true. If such streets were economically designed, with foundations of less thickness than the customary six inches, etc., it would be more true. Hence, if a street system is to be designed and built economically, as few street systems have been, certain regulations governing the use of the streets are imperative. Loads weighing more than a specified maximum, made high enough to allow coal to be hauled to residences, should be restricted to streets designed for their use. Occasional loads of this kind should be routed

by the street department; regular traffic should be required to use heavy traffic streets.

Moreover, attention is beginning to be given to the need for certain streets for slow moving and other parallel streets for fast moving traffic. This point should be given careful study in laying out and designing a street system. It may prove more economical to build two streets for different classes of traffic than one street for both. If this is true, traffic regulations would have to be prepared and enforced to ensure proper usage of the street system in this respect also. Thus it seems that traffic regulations and street design are closely related.

Advantages of Smooth Pavements

Other points that should be considered in designing streets are the character of the pavement surface itself and the location of subsurface structures. With the rapid increase in motor traffic, smoothness is becoming more than ever desirable in a pavement surface. The degree of smoothness has a direct effect upon the cost of transportation (because of the increase of tractive effort and of maintenance cost of vehicles and the necessarily reduced speeds of vehicles when operated on rough pavements), and the cost of cleaning and snow removal. In our northern states the latter is especially important. Streets must be kept open to traffic throughout the winter. Methods can be employed rapidly and economically to remove snow from smooth pavements, which cannot be used on rough pavements. The less noticeable but equally important and more costly work of street cleaning which must be carried on through eight or nine months of the year can also be done much more effectively and at considerable less cost when the streets are well paved, smooth and properly maintained. These facts explain in part the tendency to use more bituminous surface pavements than formerly. Wherever this type of pavement is used, however, on a street carrying heavy traffic economy demands that a specially designed foundation be built.

Pavement Cuts

The location of substructures has an important bearing on the problem of street layout and design. It has been shown that a system of main thoroughfares paved with properly designed and constructed pavements would be an economic asset to any city. But if pavements are to be built to withstand extreme traffic conditions, they are bound to be costly. Therefore to allow public utility corporations and the city's water and sewer bureaus to cut into such pavements repeatedly is a practice that should be avoided if possible. Each pavement cut means a break in the foundation—the real pavement—which cannot be repaired. There is no after construction factor which reduces the effective life of a pavement to a greater degree than pavement cuts. They can be avoided by placing all substructures in especially constructed galleries or elsewhere outside of the paved area of the street. This practice should be followed wherever expensive pavments are constructed.

Conclusion

In conclusion, it is admitted that many factors entering into the problem here discussed have not been dwelt upon. Nor have all features of design which must be taken into account been pointed out. To consider all of these points would require prohibitive space and are not believed essential to the purpose in mind. This article is written to indicate in a general way the scope of the paving problem and the importance of viewing it largely in each case.

The foregoing article is from a recent issue of The Cornell Civil Engineer.

CORRECTION

In the article on "Asphalt Cement Qualities and Tests Needed in Specifications for Sheet Asphalt and Asphaltic Concrete Pavements" by J. W. Howard, pp. 236, 237, June, 1920, issue of MUNICIPAL AND COUNTY ENGINEERING, the penetration test (f) should read 100 grams weight, not 200.

DESIGN OF PUBLIC COMFORT STATION FOR ALLENTOWN, PA.

By Charles E. Parry, Principal Assistant City Engineer, Allentown, Pa.

What is considered to be the most modern and up-to-date Public Comfort Station in the Eastern states is at present being constructed in Allentown, Pa. By using the terms "modern" and "up-to-date" it is meant to convey the idea of size insofar as accomodation for the quantity of population it can serve, and also the latest ideas in interior furnishings, fixtures, lighting, ventilation, and above all, sanitation.

Location and Size

The location of the station is on the Centre Square, a paved area of 130 ft. by 290 ft. between curbs, and is placed on the southeast side about 40 ft. back from the building line of the main street, i. e., Hamilton street. The outside dimensions of the whole structure are 65 ft. by 55 ft., which places it 4 ft., 6 ins. inside the curb on a 15-ft. sidewalk, on which are place the two entrances. The men's entrance is immediately off Hamilton street, and the women's 55 ft. south and more secluded, being away from general traffic.

Excavation

The street surface of asphalt was removed, as was also the 6-in. concrete foundation, beneath which was found an old heavy telford base 12 ins. thick, all of which was hauled away; the excavation was then made for the structure, being 2 ft. larger on all sides to permit of waterproofing the outsides of walls and to remove forms. Approximately 1900 cu. yds. of earth and decomposed limestone rock and shale were removed.

Concrete Footings and Walls

Upon the completion of the excavation, the footings were poured, the dimensions of which are 24 ins. wide and 12 ins. in depth, with a 1-2-4 mix; these were allowed to set for 60 hours. The wall forms were then erected of 1 in. by 12 in. dressed lumber, with 3 in. by 4 in. studs, spaced 24 ins. and wired with spacers every 24 ins. in height, with No. 10 galvanized wire. Steel-crete mesh 3-9-40 was placed inside of these forms to a height of 10 ft. above the top of footings, to withstand backfill load.

The entire 12 in. wall of the structure, the 12 in. partition and bearing wall through the center, also the 9 in.

stairway carriers, were poured in two days, using a stop off. The mixture used in these walls was a 1-2-4 with 10% hydrated lime and 20% stone dust. Cuttings made since pouring have shown an extremely dense and very hard concrete. The aggregate being crushed trap rock.

After the pouring of the walls, the various building trades roughed in everything required below the finished floor line. Upon the completion of this work, the wall forms were removed, (30 days after pouring), and a 6 in. rough concrete floor placed over the whole, with a 1-2-4 mix plain, and allowed to set six days. Upon this floor were built the forms for the replacing of the roadway on top.

The total yardage of concrete for the entire structure was 315 cu. yds.; Lehigh Portland cement was used throughout; 7,420 sq. ft. of steel-crete mesh, and 2,200 lbs. of steel rods.

The outside of all walls was tarred with hot pitch throughout the entire height, and the trench backfilled with wire mill cinders flushed and tamped.

During the excavation two pipe lines only were located; a 6 in. steam heat line from a central heating plant, and a 4 in. gas main, both of which ran directly through the site. These were cut off and looped around the building; at the same time taps were taken off each to supply the station with the necessary heat and gas; the latter being used only in connection with the hot water system for the lavatories.

T-Beam and Flat Slab Roof

It might be well to state at his poin that during the design of the structure several ways of replacing the top were considered by the writer. As there is continuous heavy truck traffic over this section, also parking of heavy loads, a loading figure of 350 lbs. per square foot was decided upon. The structure being divided into two sections—men's and women's—the span of each is 27 feet center to center. Columns were out of the question, as all clear space was desirable, on account of the various fixtures and stalls. A "T" beam and flat slab construction was decided upon as being the most economical, both in space and cost. The "T" beam is 24 ins. in depth and 15½ ins. in width, spaced on 6-ft. centers, each beam being re-inforced with five 1¼ and four 1-in. square twisted rods, with necessary stirrups; the slab is 5 ins. thick and reinforced over the entire top surface of the structure with steelcrete mesh 3-9-25. The cost of this structure is approximately one-third less than had steel beams been used, and the design adopted also reduced the depth of excavation.

The entire top of the structure, (beams and slab) were poured monolithically on two days, with one stop off, placed midway between beams. The mixture was 1-2-4, 10% hydrated lime 20% stone dust; aggregate crushed traprock from ¼ to ¾ in., soft mix.

The forms under the top were removed after 28 days, and temporary supports placed under the beams; the 2½ in. asphalt top was then replaced, rolled and opened to the general traffic.

At the time of writing the interior work is under headway, and a brief description is here given of the various installations.

Installations and Fixtures

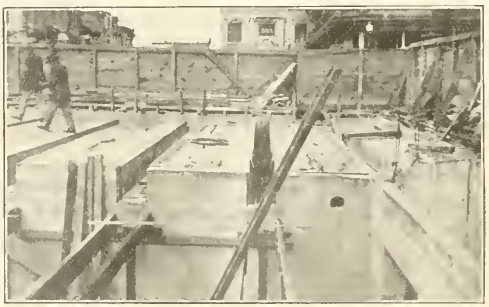
The lighting system is a rigid conduit system, controlled from a general point of distribution in the men's janitor's quarters, and each pair of outlets is controlled by a separate switch; 100-Watt nitrogen filled lamps with Holofane reflectors; nickel plated trimmings throughout.

The plumbing fixtures were supplied by the Standard Manufacturing Co., and are of vitreous china and solid porcelain throughout.

The hot water supply is furnished from a 500 gal. Rudd heater and tank, controlled by a thermostatic valve. The system is of the circulating type, which insures hot water at the fixture at the opening of the faucet. This unit is placed in the janitor's quarters on the men's side. Nickel plated sill cocks are placed conveniently in both quarters for the washing down by hose. The entire service is handled from a 3 in. water service.

Heating System

The heating system is gravity return, and is fed from the street mains of a central heating company's plant. The feed, after passing through the radiators, returns to a cooling coil, and is then trapped to the sewer. United States radiation is used throughout, and is all three column 36 in.



VIEW OF FORMS IN PLACE FOR CASTING ROOF GIRDERS AND SLABS FOR NEW PUBLIC COMFORT STATION AT ALLENTOWN, PA.

In order to insure enough fall on the return pipes, the radiators had to be raised from the floor 6 to 8 ins.; in place of using the extension legs, which are never very solid, terrazo piers or blocks were used of the same material as the floor. This makes a very pleasing appearance and facilitates cleaning.

Ventilating System

The ventilating of the station was rather a serious problem, owing to the fact of the entire structure being underground. However, this was overcome by building alongside each side and one end of each room a solid brick wall 24 ins. away from the concrete wall, leaving an air space behind the finished wall, in which space were concealed water, electric and vent ducts. At intervals on the floor and ceiling lines were inserted plain 10x12-in. registers. A large flume or duct was lead from each of these 24 in. air spaces to a 8,100 cu. ft. Bicalky fan, electrically operated, which exhausts the impure air through the small registers, and discharges it through a concrete duct to a grating in the street. The impure air is replaced by fresh air through a 24x36 in. duct in the opposite or entrance end controlled by louvres in a register.

All plumbing fixtures are back-vented to an ornamental concrete lighting column, placed on the curb line midway between the entrances; the column being built around a 20-ft. section of 8-in. wrought iron pipe, which acts as the vent duct.

Inside Finish

The walls of the station are clear white enameled brick, made by the Hytex Company of St. Louis, Mo. These are laid up with a 1-16-in. mortar joint, composed

of marble dust, white cement and lime. The completed station required 21,000 of these bricks. All door openings are trimmed with bull-nose brick, and all corners with quoins, making a clear white wall of very pleasing appearance, and thoroughly sanitary. Slots to receive the marble slabs were left in the brick wall by means of wooden strips bucked in. To stiffen the enameled brick wall, a common brick backing wall is used; the overall thickness of the entire wall being 8¼ ins.

The marble used in the stall partitions is a pink Tennessee of even color, highly polished, with marble supports and marble cap, and no pipe railing. The floor is of white Terrazo, drained to floor drains.

The ceiling is of hard white plaster on Hyrib metal lath, suspended from the beams.

All mill work, such as toilet room, rest room and trap doors is of white enameled finished throughout.

The main entrance doors are of metal, with wire glass trim, made by the Dahlstrom Metalic Door Co.

The entrance steps are of reinforced concrete, with Mason safety treads; the sides of Ceramic Mosaic tile, with suitable signs at each, and well lighted.

Telephone booths will be located in both quarters.

Quarters and Equipment

The women's quarters will be divided as follows: Three rest rooms, containing a lounge, table, lavatory and toilet, mirror, chair and toilet supplies. These will be controlled by a 10-cent coin lock on each door; a slot machine containing handkerchieves (10c) in each of these. There are three free toilets and three toilets controlled by 5-cent coin locks; six free lavatories and two handkerchief sales cabinets. In close proximity to the free lavatories will be one of the wall bracket type of air-dry electric face and hand dryers, to take the place of the free use and abuse of the paper towels. A large pier glass is conveniently installed near the entrance. The three drinking fountains are conveniently spaced in the center of the room at the entrance end.

The men's quarters will be divided as follows: One stall, containing lavatory, toilet, hot and cold shower and toilet supplies, controlled by 25-cent coin lock; three stalls, containing lavatory and toilet supplies, controlled by 10-cent coin lock; four stalls, containing toilets only, controlled by 5-cent coin lock; four stalls, containing toilets only, free service; twelve urinal stalls, free service; twelve lavatories in battery, free service, and at each end of battery will be installed a pedestal type air dry apparatus, for drying the hands and face, doing away with the use and abuse of the paper towels. A free drinking fountain is located at each end of this section.

Waste cans of the white enameled hospital type will be conveniently placed about the station for the public use. Liquid soap in proper dispensers are used throughout the station. The coin locks used in the installation are made by the American Coin Lock Co., of Pawtucket, R. I.

Janitor Service

The janitor service has not yet been decided upon. Two systems are being considered; the appointing and paying of them by the city, or by leasing the privilege to one responsible party, allowing newspaper and shoeshining privileges, or anything within reason or law. It will require two male and two female attendants, working in two shifts, as it is contemplated to give service from 6 a. m. to 11 or 12 p. m.

Cost

The cost of the entire structure, including furnishings, will be $40,000; $16,000 of which has been granted by the county commissioners as their share; the balance of $24,000 will be paid by the city by means of a bond loan.

Personnel

The writer designed the entire plant, and is supervising the construction. Mr. H. F. Bascom is the city engineer. George H. Hardner, of Allentown, is the general contractor.

CONSTRUCTION OF THE INDIANAPOLIS SEWAGE DISPOSAL SYSTEM

By J. A. Craven, Secretary, Board of Sanitary Commissioners, City Hall, Indianapolis, Ind.

The city of Indianapolis is drained by a combined system of sewers, with four drainage areas or districts, three on the east side of the White River and one on the west side. There are about 480 miles of sewers, th total area drained being about 34 square miles. The population at the present time is about 310,000, 70 per cent. with sewer service.

The dry weather flow based on a series of gagings over a period of a year is about 48,000,000 gals. daily. Of this amount less than one-half is derived from the city water supply. A large portion of the remainder is from industrial plants and the balance from the infiltration of ground water. A material reduction can be made in the volume by the elimination of condensing water at some of the larger plants, where the cleaner water can be discharged into the river or into creeks and kept out of the sewerage system entirely.

General Plan for Disposal of Sanitary Sewage

The general plan for the disposal of sanitary sewage for the Sanitary District of Indianapolis may be outlined as follows:

Sanitary sewage is intercepted and conducted by the main conduits to four different points located near the southern limits of the city and adjacent to White River. The east side main interceptor carries approximately 90 per cent. of all the sewage from this district. On account of the general topography and conditions governing the site, grit chambers and roughing racks were placed near the present outfall of this sewer, all of the sewage from the west side of the river being carried by the West Indianapolis interceptor, running through the site selected for the construction of the disposal plant.

In April, 1919, an engineering force was assembled under the direction of C. H. Hurd, consulting and supervising engineer for the Board of Sanitary Commissioners, under whose direction this work was placed by an Act of the 1917 Legislature creating the Sanitary District. The general type of construction of the sewage disposal plant for the Sanitary District of Indianapolis was determined at the time.

Interceptor, Grit Chambers and Siphon

Detailed plans for the construction of Division I were made during the spring and early summer, proposals being received and the contract awarded during the month of July to the William Grace Company of Chicago; the consideration under the contract was $321,475.

Division I of this project consists of the following features:

Subdivision A. Reinforced concrete interceptor and reinforced concrete storm-water overflow extension.

Subdivision B. Reinforced concrete grit chambers including roughing racks, valves, piping, washwater pump and mechanical equipment.

Subdivision C. White River siphon about 1,000 ft. in length, and the main sanitary conduit which is constructed of reinforced concrete, approximately 2 miles in length.

At present 20 per cent. of this contract is completed and plans are under way to speed up this construction in order to complete this division of the work by Dec. 1, 1920.

Pumping Station and Screens

Division II, covers the pumping station and equipment and the screens. While the plans and specifications are completed for the pumps and housing, contracts have been let for the pumps only. The Midwest Engine Company of Indianapolis, and the Dravo-Doyle Company of Pittsburgh, were the successful bidders, the former being awarded the contract for three 25,000,000 gal. motor-driven centrifugal pumps and the latter, three 15,000,000 gal. centrifugal pumps. The total pumping capacity of the six units is 120,000,000 gals. in 24 hours.

No definite steps have been taken with reference to screens as the action of the Board with reference to them will depend on the data derived from the experimental screen plant now in operation.

Self-Cleaning Fine Screens

What is considered an important development is sewage treatment is in the design of self-cleaning fine screens for the removal of suspended solids. These screens, which consist of revolving drums covered with No. 40 and No. 60 bronze mesh, are arranged in tandem or series permitting each screen to separate a pre-determined percentage of the screen effluent from the raw sewage, finally bringing the concentrated sewage carrying all of the larger particles of suspended matter in the form of tailings, to specially designed separators. Screens of this type have been tested under operating conditions for several months, with an unusually high efficiency on account of the fineness of the mesh used. On account of the general design of a screening plant of this character and the compactness of the arrangement, which reduces the cost of building flumes, etc., thousands of dollars will be saved to the Sanitary District. Further studies are being made in reference to the method used for the removal of the extremely fine solids and colloidal matter upon which the consulting engineer has not made a final report to the Sanitary Board.

A feature of unusual interest which has been worked out by the consulting engineer is in the design of the grit chambers in connection with the inverted siphon and sanitary conduit, which gives a constant velocity of flow through the chambers, irrespective of the quantity passing.

Final plans for the disposition of sewage sludge have not been made except that it is possible that the sludge and screenings which are removed by the newly developed rotating screens, on account of the fibrous nature and high nitrogen content, will be dewatered and transferred directly to the dryers in connection with the garbage reduction plant, now in operation.

The total cost of the sewage disposal plant will approximate $2,500,000 and should be in complete operation some time during the year 1922.

Operation of Works

Upon the completion of all construction work the operation of the works will be generally as follows:

All sewage from the east side of the river will be taken through the coarse screens or roughing racks and through the grit chambers, where all coarser floating solids will be separated as well as the heavier mineral solids. The floating solids will be disposed of by incinerators and the heavier mineral solids, in the form of sand and gravel, will be removed by the clam shell bucket, operated by an overhead traveling crane and deposited into the fill by means of a small gasoline locomotive and industrial cars. Sewage from this point, containing organic solids both in suspension and solution, will pass under White River through the inverted siphon and by a reinforced concrete conduit of horseshoe shape designed to give a minmum loss of head, will be delivered to the screen house and pumping station, located about 1500 ft. west of Harding street and White River.

The screening process for the removal of coarser suspended solids has been worked out by Mr. Hurd, so that it is possible to screen all sewage including storm water flow, except for extreme flow conditions, practically 100 per cent. of the time.

The screening process, by use of specially designed screen equipment, is carried on by gravity, the pumping of screened sewage being confined to the final purification process which will probably be brought about through the use of sprinkling filters and final sludge disposal. It is expected that the sprinkling filters will be used for final purification and they will be of the usual type with perhaps more than the average depth, being surrounded by concrete wells to permit flooding and operated on short interval periods, accomplished by the use of electrically operated undulating valves.

The foregoing matter is from a paper Mr. Craven presented at the 1920 convention of the Indiana Sanitary and Water Supply Association.

RECOMMENDED SALARIES FOR ENGINEERS IN MUNICIPAL SERVICE

By S. C. Hadden, Editor of Municipal and County Engineering, Chicago, Ill.

(The major portion of the present article was written for the May, 1920, issue of the "Professional Engineer," the official journal of the American Association of Engineers. At that time the salary schedules were made public to draw out comments from engineers. All the comments received were in the last degree gratifying to those who formulated the schedules. The schedules as proposed were formally adopted without change by the Board of Directors of the American Association of Engineers on May 10, 1920. The portions of the original article thought to possess permanent interest and value, including, of course, the schedules, are here reproduced. The author has added, in the present article, his ideas on how these schedules may be made effective.)

As long as anyone can remember, professional engineers in the service of cities have been underpaid. This was a notorious fact for decades preceding the outbreak of the great war in 1914. Since then such adjustments in the salaries of these engineers as have been made are not at all comparable with the increase of wages of laborers, mechanics, foremen and those employed in the various building trades. The terrific increase in the cost of all the bare necessities of life, affecting all alike, has operated to reduce the purchasing power of these salaries, which were so inadequate in 1914, until today the municipal engineer finds himself poor indeed.

Organization of Parent Committee

Recognizing that relief for professional engineers in the public service must be forthcoming, not only as a matter of simple justice to individuals affected but to safeguard public interests as well, the American Association of Engineers at the 1919 annual convention appointed a Committee on Salaries of Engineers in Public Service to draft schedules defining the duties and recommending salaries for engineers in the public service.

This parent Committee consisted of A. R. Hirst, state highway engineer of Wisconsin; J. H. Prior, consulting engineer on public utilities, Chicago; F. H. Newell, then president of the association; S. C. Hadden, editor of Municipal and County Engineering, and A. N. Johnson, chairman, consulting highway engineer of the Portland Cement Association, Chicago. The parent committee drew up schedules, which the Board of Directors of the association adopted, defining the duties and recommending salaries for engineers in state highway service, and also for engineers in county highway service. The schedule for engineers in state highway service was approved by the Association of State Highway Officials and by the American Road Builders' Association.

Organization of Sub-Committee

To a sub-committee was delegated the task of drawing up similar schedules for engineers in municipal service. The sub-committee consisted of S. C. Hadden, editor of Municipal and County Engineering, Chicago, chairman; John Ericson, consulting engineer of the Board of Public Works of Chicago; W. W. Horner, chief engineer of sewers and paving, St. Louis; George D. Earl, general superintendent of the Sewerage and Water Board of New Orleans; O. Laurgaard, city engineer of Portland, Oregon; E. R. Conant, consulting engineer of Brunswick, Georgia, (for many years city engineer of Savannah and past president of the American Society for Municipal Improvements); John Chambers, city engineer of Louisville, Kentucky; William W. Brush, deputy chief engineer, Department of Water Supply, Gas and Electricity, New York City; F. L. Raschig, principal assistant engineer, Board of Rapid Transit Commissioners, Cincinnati, Ohio; Arthur A. Reimer, consulting engineer of East Orange, N. J. (for many years water engineer of East Orange); H. P. Machen, Major, Ordnance Department of the U. S. Army, Washington, D. C. (formerly borough engineer of the Boroughs of Manhattan and Bronx, New York City); A. B. Farnham, city engineer, Pittsfield, Massachusetts; F. C. Lohman, city engineer of Champaign, Illinois; G. D. Fairtrace, city engineer of Dallas, Texas; O. E. Carr, city manager of Springfield, Ohio; L. B. Hitchcock, city engineer of Phoenix, Arizona; S. Q. Cannon, city engineer of Salt Lake City, Utah; W. J. Alexander, city manager, Gastonia, North Carolina; E. A. Zeisloft, city engineer of Akron, Ohio; Guy H. Stevens, city engineer of Auburn, Maine, and W. G. Baldry, city engineer of Topeka, Kansas.

Procedure of the Sub-Committee

The reader will note that the members of the sub-committee represented cities of all sizes in all parts of the United States. The studies of the committee were largely conducted by correspondence. While this required considerable time it also necessitated careful work and fully developed all the ideas of each member of the committee.

The committee was chosen in the early Autumn of 1919, and took up its investigation according to a set of fundamental principles laid down by the chairman to govern the deliberations of the committee, and approved by the members of the committee.

Each member of the committee submitted data pertaining to the engineering organization of the city he represented and many of the members of the committee also submitted data pertaining to other cities. From these data, with data on file at the national headquarters of the association pertaining to many other cities, and with the very elaborate reports on compensation which have been worked out by various local chapters of the association, the chairman of the sub-committee drafted tentative schedules for municipal engineers in collaboration with Mr. A. N. Johnson, chairman of the parent committee and with Mr. C. E. Drayer, secretary of the association. These tentative schedules were then submitted to the members of the sub-committee for criticism. As a result of the helpful criticisms received in thsi way the tentative schedules were revised at some points so as to comply as nearly as practicable with the thoughts of each member of the sub-committee. The schedules here presented, in the form adopted, therefore, are the results of many months of the most painstaking study and research, each member doing his full share of the work.

Comments on the Schedules

It will be noted that five schedules are recommended pertaining to cities of different sizes as indicated. It is not intended that any one of these schedules should constitute an organization chart for any local community. The schedules are intended to be of general assistance in arriving at fair compensation for engineers in municipal service.

In adopting the schedule of salaries for engineers in state highway service, there were established salaries for three places in the schedule, namely, the highest, the middle position and the lowest. With these positions established the others fell readily into line. Later the county highway schedule was adopted in a form consistent with the state highway schedule, and, of course, the schedule of salaries for engineers in municipal service, now adopted, has been governed to a considerable extent, particularly in the lower grades, by comparisons with the schedules earlier adopted. It is, of course, logical that the municipal schedule should be similar in form and substance to the state and county highway schedules.

It will be noted that the salaries are predicated on population rather than on the amount of work done,

although the latter basis is not without its advocates. A large majority of the committee agreed with the chairman that as a rule the amount of work done will be directly proportional to the size of the city and that in a schedule intended for general application variations from the normal cannot be considered.

The first schedule is for cities up to a maximum of 15,000 population, beginning with smaller cities, of course, employing full time engineers. The fifth schedule applies to cities not exceeding 500,000 population. It was not thought wise by the committee to propose a schedule at this time for cities over 500,000 population. The local chapters of the association can no doubt handle the few cases of that class much better than could the association itself, because of great knowledge of local conditions and local organization. Moreover, this work is far advanced in some of the larger cities, and was at the time the work of this committee was undertaken. It is recognized also that the form of engineering organization in these larger cities varies so much from one locality to another that individual study and recommendations are essential, not only to secure results, but to secure consideration. Generally speaking, it has been considered impracticable to list all municipal engineering positions in existence in the cities covered by these schedules, but it is thought that sufficient points of control are established for the guidance of those who wish to make specific recommendations in any given locality. Therefore, a multiplicity of grades in the minor positions have not been recognized in the schedule, and it is important to note that the first grade is intended in all cases, unless second grades are given, and lower grades will naturally be made consistent with these in local recommendations later predicated on these general schedules.

The schedules include some positions which should be filled by professional engineers which are commonly filled by non-technical men. Surely it is time to recognize these positions as engineering positions and to fix for them salaries which will make them attractive to trained engineers.

The water department has been separated from the city engineering department in all cases, as that is the usual, although not the invariable, practice in cities of all sizes throughout the country. The position of city manager, unquestionably one of the first order of importance, has been placed in a footnote to the final schedule. This was done to prevent confusion in localities where this form of municipal organization does not exist. The city manager movement has not yet made sufficient headway to warrant inclusion of this grade in each schedule. This is in no way intended as a reflection on the demonstrated merit of the city manager form of municipal government.

Many may feel that the salaries given in schedule 1 are too high. On the other hand, some members of the committee have specifically commended the salaries in schedule 1, as it is recognized that these smaller cities need competent engineers. The engineering employee of the small town has many peculiar handicaps and difficulties with which to contend. He is not only subjected to the most troublesome kind of political and personal influence, but he seldom has adequate funds with which to work. In no other place can a competent engineer so quickly save the amount of his annual salary as in these smaller cities. Naturally these salaries should be such as to attract and hold competent men.

The salaries scheduled are considered the minimum which cities should pay their engineers. As each schedule applies to cities within certain limits of population the lower figure named for any grade is for the smallest city of the group covered by the schedule and the higher figure is for the largest city in the group. In schedule 1, the lowest figures are for the smallest cities employing full time engineers.

The five schedules follow:

Schedule 1—Cities up to 15,000 Population

CITY ENGINEER In charge of all engineering work of the city except water works.	$ 3,500—	$ 5,200
FIRST ASSISTANT ENGINEER Duties as assigned; no executive work.	2,400—	3,000
SECOND ASSISTANT ENGINEER Performs or has charge of drafting and surveying work.	1,800—	2,400
RODMAN AND CHAINMAN	1,200—	1,600
INSPECTOR ON CONSTRUCTION WORK, FIRST CLASS	2,400—	3,000
INSPECTOR ON CONSTRUCTION WORK, SECOND CLASS	1,200—	1,600
SUPERINTENDENT OF WATER WORKS. In charge of maintenance, operation and extension of water works system.	1,800—	3,600
SUPERINTENDENT OF STREETS AND SEWERS. In charge of maintenance of city streets and sewers.	1,800—	3,000

Schedule 2—Cities from 15,000 to 50,000 Population

CITY ENGINEER In charge of all engineering work of the city, except water works.	$ 4,800—	$ 6,000
FIRST ASSISTANT ENGINEER Duties as assigned but responsible for office engineering work.	2,400—	3,600
SECOND ASSISTANT ENGINEER Chief of survey party and supervising engineer on construction.	2,400—	3,600
INSTRUMENTMAN	1,800—	2,000
DRAFTSMAN	1,800—	2,400
RODMAN, CHAINMAN AND TRACER	1,200—	1,600
INSPECTOR ON CONSTRUCTION WORK, FIRST CLASS	2,400—	3,000
INSPECTOR ON CONSTRUCTION WORK, SECOND CLASS	1,200—	1,600
SUPERINTENDENT OF WATER WORKS. In charge of surveying operations and supervision of water works system.	3,600—	5,000
SUPERINTENDENT OF STREETS AND SEWERS In charge of maintenance of city streets and sewers.	2,400—	4,000

Schedule 3—Cities from 50,000 to 100,000 Population

CITY ENGINEER In charge of all engineering work of the city except water works.	$ 5,500—	$ 7,500
DEPUTY CITY ENGINEER Office engineering and special work as assigned.	3,200—	4,800
DIVISION ENGINEER In charge of surveying operatins and supervision of city construction work.	3,000—	4,500
ASSISTANT ENGINEER Reports to division engineer and acts as chief of	2,800—	3,600
INSTRUMENTMAN party or construction superintendent.	2,200—	3,000
DRAFTSMAN	2,200—	3,000
RODMAN, CHAINMAN AND TRACER	1,500—	1,800
INSPECTOR ON CONSTRUCTION WORK, FIRST CLASS	2,600—	3,200
INSPECTOR ON CONSTRUCTION WORK, SECOND CLASS	1,500—	1,800
SUPERINTENDENT OF WATER WORKS. In charge of maintenance, operation and extension of water works system.	4,500—	6,000
SUPERINTENDENT OF STREETS AND SEWERS In charge of maintenance of city streets and sewers.	3,600—	4,800

Schedule 4—Cities from 100,000 to 300,000 Population

DEPARTMENT COMMISSIONER Commissioner of department of public works or head of special commission as on transportation, sewage disposal, additional water supply or other similar work of the first magnitude.	$ 7,500—	$10,000
CITY ENGINEER In charge of all engineering work of the city except water works.	7,000—	8,500
DEPUTY CITY ENGINEER Principal assistant to city engineer assigned to special work.	4,800—	5,400
DIVISION ENGINEER In charge of major subdivision of the city engineering work such as pavements, sewers, bridges, etc.	4,000—	4,800
OFFICE ENGINEER In direct charge of design, reporting to division engineer.	3,600—	4,000

ASSISTANT ENGINEER, FIRST GRADE	3,200—	3,800
ASSISTANT ENGINEER, SECOND GRADE	2,800—	3,100
Reports direct to division engineer and acts as chief of party, squad leader or construction superintendent.		
TESTING ENGINEER, CHEMIST OR BACTERIOLOGIST	3,200—	3,800
In charge of testing work in construction material laboratory, water purification plant or sewage treatment plant.		
INSTRUMENTMAN	2,400—	3,200
DRAFTSMAN, FIRST GRADE	2,400—	3,200
DRAFTSMAN, SECOND GRADE	1,800—	2,100
RODMAN, CHAINMAN AND TRACER	1,700—	2,000
INSPECTOR ON CONSTRUCTION WORK, FIRST CLASS	2,800—	3,400
INSPECTOR ON CONSTRUCTION WORK, SECOND CLASS	1,700—	2,000
SUPERINTENDENT OF WATER WORKS	5,000—	7,000
In charge of maintenance, operation and extension of water works system.		
ASSISTANT WATER SUPERINTENDENT	3,600—	4,800
In charge of domestic distribution system.		
WATER WORKS MECHANICAL ENGINEER	3,600—	4,800
In charge of pumping plants of city water works.		
SUPERINTENDENT OF METERS AND SERVICES	3,600—	4,800
In charge of installation of water meters, service pipes and meter reading.		
SUPERINTENDENT OF WATER FILTRATION	3,600—	4,800
In direct charge of city water purification plant.		
SUPERINTENDENT OF STREETS	3,600—	4,800
In charge of maintenance of streets, including street cleaning and refuse collection.		
SUPERINTENDENT OF SEWERS	3,600—	4,800
In charge of sewer maintenance, repairs and new connections.		
SUPERINTENDENT OF SEWAGE DISPOSAL	3,600—	4,800
In direct charge of sewage disposal plant operation.		
SUPERINTENDENT OF REFUSE DISPOSAL	3,600—	4,800
In charge of municipal refuse destructor or incinerator.		

Schedule 5—Cities from $300,000 to 500,000 Population

DEPARTMENT COMMISSIONER	$10,000—	$15,000
Commissioner of department of public works or head of special commission as on transportation, sewage disposal, additional water supply or other similar work of the first magnitude.		
CITY ENGINEER	9,000—	12,000
In charge of all engineering work of the city except water works.		
DEPUTY CITY ENGINEER	6,000—	7,500
Principal assistant to city engineer assigned to special work.		
DIVISION ENGINEER	4,200—	6,000
In charge of a major subdivision of the city engineering work such as pavements, sewers, bridges, etc.		
OFFICE ENGINEER	3,800—	4,200
In direct charge of design, reporting to division engineer.		
ASSISTANT ENGINEER, FIRST GRADE	3,400—	4,000
ASSISTANT ENGINEER, SECOND GRADE	2,900—	3,300
Reports to division engineer direct and acts as chief of party, squad-leader or construction superintendent.		
TESTING ENGINEER, CHEMIST OR BACTERIOLOGIST	3,400—	4,000
In charge of testing work in construction material laboratory, water purification plant or sewage treatment plant.		
INSTRUMENTMAN	2,400—	3,200
DRAFTSMAN, FIRST GRADE	2,400—	3,200
DRAFTSMAN, SECOND GRADE	1,800—	2,100
INSPECTOR ON CONSTRUCTION WORK, FIRST CLASS	2,800—	3,400
INSPECTOR ON CONSTRUCTION WORK, SECOND CLASS	1,700—	2,000
RODMAN, CHAINMAN AND TRACER	1,700—	2,000
SUPERINTENDENT OF WATER WORKS	7,500—	10,000
In charge of maintenance, operation and extension of water works system.		
ASSISTANT TO WATER SUPERINTENDENT	4,800—	6,000
In charge of domestic distribution system.		
WATER WORKS MECHANICAL ENGINEER	4,800—	6,000
In charge of pumping plants of city water works.		
SUPERINTENDENT OF METERS AND SERVICES	4,800—	6,000
In charge of installation of water meters, service pipes and meter reading.		
SUPERINTENDENT OF WATER FILTRATION	4,800—	6,000
In direct charge of city water purification plant.		
SUPERINTENDENT OF STREETS	4,200—	6,000
In charge of maintenance of streets, including street cleaning and refuse collection.		
SUPERINTENDENT OF SEWERS	4,200—	6,000
In charge of sewer maintenance, repairs and new connections.		
SUPERINTENDENT OF SEWAGE DISPOSAL	4,800—	6,000
In direct charge of sewage disposal plant operation.		
SUPERINTENDENT OF REFUSE DISPOSAL	4,200—	6,000
In charge of municipal refuse destructor or incinerator.		

These schedules not to operate to reduce any existing salaries.

Where a city manager is employed his position shall be defined as the administrative head of the municipality, appointed by its legislative body, and his duties make him the head of the service, safety, health and welfare departments of the city. The following salaries are proposed for city managers.

Schedule 1, from $5,000 to $7,500; schedule 2, from $7,000 to $8,500; schedule 3, from $8,500 to $10,000; schedule 4, from $10,000 to $12,000; schedule 5, from $12,000 to $15,000.

Making the Schedules Effective

Now that we have the schedules, of what benefit are they to the individual municipal engineer? First of all they give him a standard with which to compare his present salary to ascertain just how much he really is underpaid. That these schedules form a fair standard of comparison, the author does not hesitate to assert, for they were weighed and tested at every point by a considerable number of engineers before they were adopted and made public. Since this large group of engineers have agreed that these salaries are certainly not excessive, the individual engineer will do well to base his requests for salary increases on the figures here given. It is hoped these schedules will give the individual at least a part of the backing he needs in his efforts to secure just and adequate compensation. It was no part of the purpose of those who have done this work to make the individual municipal engineer dissatisfied, if he has been satisfied, to make him unhappy if he has been happy, or to make him a "knocker" or disorganizer if he has been loyal. But it is hoped that the schedules will in every way be a stimulus to the engineer, not only to increase his happiness and his expectations, but to fill him with the determination to realize those expectations.

The individual can accomplish much for himself by his own well-considered efforts, but he can accomplish vastly more in co-operation with other engineers. Municipal engineers must realize that insofar as they are all underpaid they are all "in the same boat." Each man must do all he can to help every other man. Let him think not of engineer against engineer, but of engineers against "the field." There must be an effort to lift the other fellow up instead of pulling him down or holding him down. Those at the top of the list can help themselves by helping those in the lower grades. Probably the increases can better be secured from the bottom up instead of from the top down. Comparison with laborers should help in the lower grades and then raises of the higher grades will inevitably follow if they are frankly and fairly sought.

The schedules will be an invaluable guide in making up budgets and of much assistance in putting the budgets through. Beyond a question of doubt city councils and other salary fixing agencies in cities will be disposed to regard these schedules as the true measure of the value of engineering services when endorsed and brought forward by the engineers of the locality.

Local chapters and clubs of the American Association of Engineers can do a very great deal by way of getting action on these schedules, and they are even now doing so. As we write, the news comes that the Terre Haute, Ind., chapter has adopted a resolution endorsing the salary schedules of the association and is taking steps to introduce bills in the 1921 legislature to secure an improvement in the working conditions and salaries of all the municipal and county engineers in the state. All the chapters and clubs of the association in the state will doubtless co-operate in this movement to have the state's laws affecting engineers revised. The same will be done in other states.

These suggestions point the way to a realization of the

salaries scheduled. Co-operation is imperative. It is a case of: "All for one, and one for all."

RELATION OF TRACTOR AND TRAILER TRAFFIC TO HIGHWAY DESIGN

By H. Eltinge Breed, Consulting Highway Engineer, 507 Fifth Ave., New York City.

Tractor and trailer traffic is a sure thing. Highway design is a glittering uncertainty.

By tractor and trailer traffic being a sure thing, I mean just this: It is here to stay. There are registered in the country today 35,000 trailers. That is definite. So is their percentage of increase in the last two years: over 100 per cent. At this rate of increase we can plan for 500,000 or more tractors and trailers by the year 1930. The only uncertain factor is whether the rate of increase will itself increase, and how much. I believe that we should plan for at least double the number of tractors and trailers given above.

Events of the last two years have caused many doubts as to whether the great occasion always does produce the great man—but, at least, in this mechanical age of ours, the advent of the tractor and trailer is one indication that the great industrial need always produces the means to fulfill it.

Meeting the Need of Distribution

The crux of the economic situation as I see it in this country today is, even more than production, distribution: distribution of the products of the soil, of labor, of machines; and fairer distribution of the wealth that accrues from these products. The motor truck and the tractor and trailer have been developed to meet the need of distribution.

The railroads cannot meet this need. Industries in the Middle West are being forced daily to shut down because of the shortage of freight cars for the transportation of material. Farmers the country over are frantic with anxiety about the movement of their crops. Congress, and the Interstate Commerce Commission, and the Car Service Bureau and many others squabble and muddle along with no prospect of adequate solution. Whatever relief we get this year and next will be from motor transportation.

Motor Power for Short Haul Freight Is Economical

Much as we need distribution we need even more economy in distribution. It is appalling to realize that we, as consumers, pay from 3 to more than 10 times the actual cost of the finished article, be it manufactured or natural product. It is disquieting to reflect that we are the only rich nation in a bankrupt world. It is still more disquieting to hear the hollow reverberations of much of our wealth. Whatever effects a saving in cost to the consumer is a national boon. Motor power for short-haul freight does effect such a saving. That, I believe, is the great reason for its rapid growth. Mr. Banham says: "I find that if we combine all the costs, such as additional crating, labor, etc., to make a less than carload shipment, the rate averages a dollar a hundred from Yonkers to Newark. If you take the same movement by motor trucks or tractor and trailer, with decreased boxing, weight and labor, the rate averages 20 cts. For 12 miles, then, there is a difference of 80 cts. per hundred pounds in favor of the motor truck. The saving in time, in space for storage, in materials, are all in favor of transportation by motor."

There is also the very important saving in gasoline which results from the use of the tractor and trailer over the ordinary truck. The trailers make it possible for one tractor truck, one driver and one motor to do the work of three trucks. With the trucks, they have met the industrial need. Today, in the tie-up in New York harbor, they are coming to the rescue, and moving the foodstuffs. More and more they are becoming to the great cities the strongest assurance of a sufficient food supply. Those in New York City who had babies or invalids to care for during the milk crisis in January 1919, will remember with gratitude the Walker Gordon milk trucks.

Roads Must Be Designed for the Loads They Bear

But in the uncertainty of highway design, motor transportation suffers a serious check. I say "Uncertainty" because this spring improved roads have gone to pieces as they never have before. The Lincoln Highway between Trenton and Philadelphia has completely "busted up." Some people say that the damage is due to the hard winter. That I disbelieve. Weather is a natural process that should not hurt a healthy, protected organism, either human or highway. The roads are organically wrong, because they are not designed for the loads they must bear. Unless they can sustain the necessary traffic they do not fulfill their function. They hinder, instead of help, distribution. The saving effected by motor transportation more than offsets the cost of the roads that are essential to this transportation. The economic value of good roads to the country cannot be expressed wholly in terms of the dollar.

Wide Roadways

Adequate design of highways for tractor and trailer traffic, means an immediate provision for three lines of traffic near all large cities and on all trunk routes, with possibility of an added 10 ft. longitudinally for the fourth line. For each line of traffic at least 9 ft. should be allowed. The additional width is necessary because tractors and trailers move at a speed of from 6 to 12 miles an hour, and other cars, going from 12 to 40 miles must have room to pass.

Turns must be widened because of the greater length of the tractor and trailer, and curves must be super-elevated in order that they may keep in their own line of traffic.

Economy of Grade Reduction

With the increasing cost of motor fuel, special attention must be given to reducing grades. The consumption of gasoline increases directly with an increase in grade. On a fairly level road you can haul a heavier load with less fuel. This saving on main roads heavily travelled often compensates in two or three years for whatever additional cost is involved in reducing grades.

Because of the distribution of load over 6 or 8 wheels, and because of their slower movement, tractors and trailers are less hard in impact upon pavement than heavily loaded trucks. They would not require any greater strength of foundation or better type of surfacing than

we would provide for regular heavy traffic, but all heavy traffic requires an adequate foundation and a durable type of pavement. A semi-durable pavement for heavy traffic is sheer waste.

I become more and more convinced, however, that the final success of road building depends upon the intelligence of the public. The public must not only demand good roads, but that part of the public represented by the National Highway Traffic Association must know enough about what constitutes good roads to act as a spur to the sometimes sluggish consciences of engineers and contractors. Public knowledge prevents private graft.

Good roads require an alert, intelligent public, engineers with vision, competent contractors. These factors, and the training in Highway Engineering that some Universities are now giving, and the urgency of the need itself, will gradually produce Highways that will be adequate to the demands of Tractor and Trailer Traffic.

The foregoing paper by Mr. Breed was presented at the 1920 annual meeting of the National Highway Traffic Association in New York City.

EXTENSION OF 18th ST. KENTUCKY ROCK ASPHALT ROAD, LOUISVILLE, KY.

A contract was recently let for resurfacing with Kentucky Rock Asphalt the extension of the famous Eighteenth Street Road at Louisville, Ky., for a distance

VIEW OF OLD KENTUCKY ROCK ASPHALT SECTION OF 18TH ST. ROAD, LOUISVILLE, KY.

of 11.1 miles from the end of the present Kentucky Rock Asphalt section to the Jefferson County line.

The rock asphalt section of this road (about seven miles) has aroused nation-wide interest because of the remarkable test which it withstood during the war. At one end of the road was Camp Knox, an artillery encampment. On the other side of the City of Louisville was Camp Taylor and just across the Ohio River at Jeffersonville, Ind., was the great army supply depot. All the heavy traffic between Camp Knox and the two military points, passed over the Eighteenth Street road. A careful estimate showed an average of 4,000 vehicles, most of them trucks, a day (12 hours) for almost two years.

In spite of this severe test, the rock asphalt section of this road is in excellent condition today—there is not even a crack in its surface.

The 11.1 miles extension, which has just been let, is at present a 16 ft. macadam roadway, surface-treated. The old surface will be lightly scarified and covered with 3 ins. of new metal compacted. On top of this Kentucky Rock Asphalt will be laid cold and compacted to a thickness of 2 ins. In addition, the roadway will be widened to 20 ft. Specifications call for 9 ins. of compacted metal and 2 ins. of compacted rock asphalt for the 2 ft. extension on each side of the present roadway.

The road will be relocated for four miles. Grading of this section will be done this year, the surface placed next year. This new construction calls for a 9 in. compacted macadam base and 2 in. compacted Kentucky Rock Asphalt top 20 ft. wide.

J. H. Cahill, Louisville, Ky., has been awarded the contract for the work.

DESIGN OF SMALL STORM-WATER PUMPING STATION AT DAYTON, O.

The accompanying drawing shows an elevation and plan of a small storm-water pumping station built in Dayton, Ohio, in 1919. It is designed to pump storm water sewage during high stages of the river.

The station is located on the west bank of the Miami River near the railroad bridge and immediately adjacent to the Germantown street storm water sewer. The Germantown street storm water sewer drains the territory bounded by Third street on the north, Broadway on the west, the Pennsylvania railway on the south, and the Great Miami River on the east.

A part of this area is the lowest in the city with respect to the water in the Miami River, and the flood gate at the outfall of the Germantown street sewer is the first to be closed as the water in the river rises.

Before this pumping station was built the storm water which fell after the closing of this flood gate must necessarily collect at the lowest point, which is located at the intersection of Germantown and Louie streets, and stay there until the water in the river receded to a point where the flood gate could be again opened.

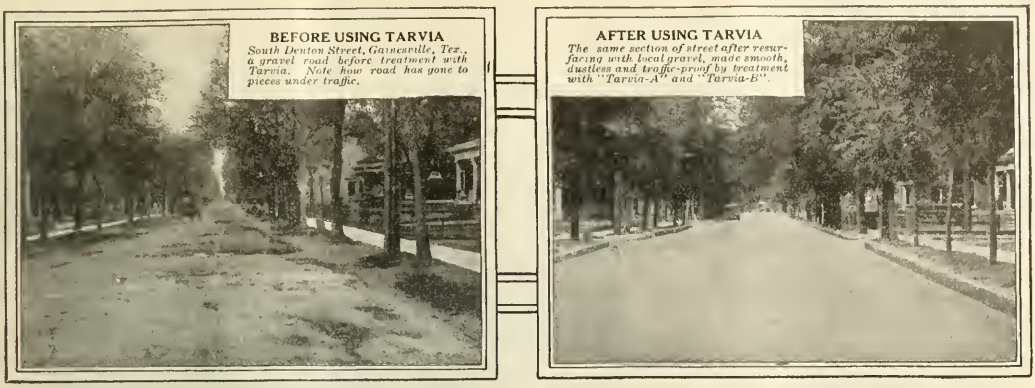
With the completion of the pumping station this very annoying condition has been done away with.

Pumping Equipment

The station is equipped with two 14-in. single stage, double suction centrifugal pumps, manufactured by the Platt Iron Works of Dayton. Each is capable of discharging 4,200 gals. per minute against a total head of 22 ft. They are driven by two 40 h.p. Westinghouse, 3 phase, 60 cycle, 220 volt, induction motors having a speed of 870 revolutions per minute. The motors are direct connected to the pumps by means of flexible couplings.

Artificial Priming

The suction lift is 10 ft. which necessitates artificial priming of the pumps. This may be accomplished in two ways: (a) By exhausting the air in the suction line with a Gardner-Rix vacuum pump, which has been installed for that purpose. (b) There are also provided foot valves on the ends of the suction lines so that the latter may be primed with water. A 1½-in. water line


BEFORE USING TARVIA
South Denton Street, Gainesville, Tex., a gravel road before treatment with Tarvia. Note how road has gone to pieces under traffic.
AFTER USING TARVIA
The same section of street after resurfacing with local gravel, made smooth, dustless and traffic-proof by treatment with "Tarvia-A" and "Tarvia-B".

"There are no arguments against saving what you've got"—

THE war taught us many things, not the least of which was thrift—pertinently termed "saving what you've got." Thrift showed us that last year's shoes could be resoled and that the old suit—with little mending and pressing—had another year's wear in it.

It showed many cities and towns that the policy of "saving what you've got" could be applied to their road problems. They reasoned this way:

"High costs may offer good arguments for delaying new road construction at this time, but *there are no arguments against saving what you've got.* To neglect the roads already built is waste, and *waste is a crime.*"

If your macadam roads are good, keep them good; if they're in bad shape, *repair them!*

That may mean Tarvia patching and surface treating; the widening of narrow roads by adding Tarvia macadam shoulders or it may mean utilizing the old macadam as the foundation for a traffic-proof Tarvia top.

Road improvements like these are not makeshift methods. They are the logical solution of the good roads problem in hundreds of communities today.

Best of all, the cost is low, the maintenance cheap and the satisfaction a blessing to the entire community.

Tarvia roads are mudless, dustless, waterproof and frost-proof. The smooth-running, durable surface resists the hardest traffic.

Our engineers will gladly consult with you, without obligation, in solving your road problems with Tarvia.

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.

Illustrated booklets of the various Tarvia treatments free on request.

Address nearest office.

Gravel road in Brideton, Maine, maintained with "Tarvia-B".

Tarvia

Preserves Roads—Prevents Dust

New York, Cincinnati, Minneapolis, Atlanta, Lebanon, Chicago, Pittsburgh, Dallas, Duluth, Youngstown, Philadelphia, Detroit, Nashville, Salt Lake City, Milwaukee

The Barrett Company

Toledo, Columbus, Richmond, Latrobe, Bethlehem, Boston, New Orleans, Syracuse, Bangor, Elizabeth, St. Louis, Birmingham, Seattle, Washington, Buffalo, Cleveland, Kansas City, Peoria, Johnstown, Baltimore

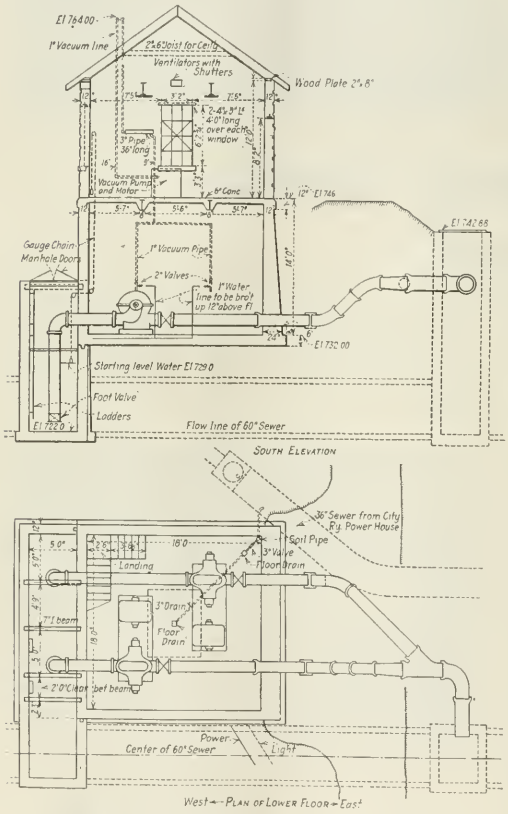
THE BARRETT COMPANY, Limited, Montreal, Toronto, Winnipeg, Vancouver, St. John, N.B., Halifax, N.S., Sydney, N.S.

runs from the City Railway power house to the tops of the pump casings for this purpose.

The pumping equipment is located in the basement of the building and the controlling apparatus on the ground floor. The building is 20 ft. square and is built of red rug-texture brick. It has a red Spanish tile roof.

Cost of the Station by Day Labor

The following is an analysis of the cost of the station:



PLAN AND SECTION OF GERMANTOWN STREET, STORM WATER PUMPING STATION, DAYTON, O.

Building materials	$ 2,120.00
Labor	2,282.60
Machinery and equipment	4,855.54
Tools and supplies	322.00
Incidentals	385.00
Contract work	1,523.00
Lumber (sheeting)	641.50
Total	$13,129.64
Engineering	558.06
Grand Total	$13,687.70

An appropriation of $20,000 was made to cover the cost of this station in 1915 when the million-dollar bond budget was put up to the people. An effort on three different occasions was made to secure a bid for its construction. At no time did the lowest bid received come within the estimate of $20,000. The lowest bid received was $25,000, and proposals as high as $36,000 were submitted by contractors. This condition caused the city to undertake the work under its own supervision. Mr. F. O. Eichelberger, then City Engineer and now Director of the Department of Public Service, had direct charge of the design and construction of the station.

SAVING THE TREES OF BROOKLYN

How to save the trees of Brooklyn by careful forestry practice is a problem which has just been submitted to the New York State College of Forestry at Syracuse by prominent Brooklyn men as the result of a street tree investigation made by the head of the Department of City Forestry at the State College.

It is suggested that an area of Brooklyn streets be taken, planted and maintained as a joint experimental problem for the period of at least ten years by the State College of Forestry and the Brooklyn Botanic Garden, carried out by funds supplied by interested citizens of Brooklyn. It is said that the trees of Central Park have been in danger of dying out entirely and the Brooklyn proposition is the result partly of the college's forestry work on these trees.

This would probably be the first research problem of its kind ever systematically undertaken.

COUNTY COMMITTEE SELECTS ASPHALT

By John Morrison, Southern Division, Asphalt Sales Department, The Texas Company.

An efficacious plan to select the correct type of pavement has been inaugurated in Jefferson County, Alabama. Instead of the old method of receiving bids and then awarding a contract on a certain type of pavement to the lowest bidder, this county has instituted what is known as a Road Advisory Committee. This body is composed of seven members, three of them being technically educated men and the other four are men of business and financial interests.

In the adoption of such a plan it was desired to have business men and financial experts give their ideas as well as the technical men in the selection of a durable, lasting type of highway. As the result of a thorough investigation, the committee decided that asphalt pavements were best suited to endure the heavy traffic of the county.

Jefferson County has let already $2,000,000 worth of road work and all of it has been of asphaltic pavements. The county has voted $7,000,000 for improved highways, and work already let calls for two types of asphaltic construction. One is for asphaltic concrete using a Topeka mix. This type will have a concrete base 5 to 7 ins. in thickness, and a 2-in. wearing surface. The other type selected is sheet asphalt with a base of 5 to 7 ins., a 1½-in. binder, and a 1½-in. wearing surface.

WATER WORKS SECTION

RESERVOIR PRESSURE VS. DIRECT PRESSURE IN WATER SYSTEMS

By W. R. Gelston, Superintendent, Water Works Commission, Quincy, Ill.

The design and construction of a water works system for any given city is a separate and distinct problem in itself, and that problem should be solved by a competent engineer. Undoubtedly, the engineer is now playing a larger part in the design of water works plants than formerly. There are still in existence, however, many relics of the days when venerable city fathers drove hard bargains with the owners of water works plants and forced them to furnish, not only the water for fire protection, but also the high pressure which was necessary in order to make the water effective. By such displays of wisdom, on the part of venerable city fathers, the taxpayers of many cities were saved the expense of purchasing and maintaining fire engines, it is true, but the venerable city fathers did not look far enough into the future.

Many of those misfit water works plants are now owned by the cities they serve and those which are not owned by the cities are allowed, by the various rate making bodies, to charge rates which will pay proper returns on the investment in the extra heavy mains which are necessary to withstand the high fire pressures and the excessively high operating costs which result from continuous pumping into a closed system. So the taxpayers "chickens have finally come home to roost" in spite of the wisdom of the venerable city fathers.

Reservoir pressure is not practicable in many cities which are located on level ground, at considerable distances from ground which is high enough to give the desired pressure, but such cities may use elevated tanks instead of reservoirs if the consumption of water is not too great.

Many small cities which are now contemplating the construction of water systems may profit from the experience of the city of Quincy, Illinois, with a reservoir pressure system. It is also possible that there are some cities which are now afflicted with the direct pressure systems, which might profitably change to the reservoir or tank system.

The Quincy System

The Quincy water supply is pumped from the Mississippi River. The pumping station is located on the bank of the river at Maine Street. Maine Street is the principal business street and it runs east and west. The city extends 1¼ miles northward from Maine Street and about the same distance to the south. It extends 2½ miles, from the river, eastward along Maine Street.

The water is pumped from the river to the sedimentation basin which is located near the pumping station. The water is coagulated, settled, filtered and sterilized with liquid chorine, as it flows by gravity from the filter plant back to the pumping station. It is then pumped a second time, into the distribution system and reservoir.

The Reservoir

The reservoir was built in 1882, upon the highest hill within the city limits. It is a little less than two miles east of the pumping station and three-quarters of a mile north of Maine Street. The top of the hill upon which it is located was originally about 230 ft. above low water mark in the river. The reservoir was built with earth embankments 15 ft. wide on top, using material which was excavated from within the reservoir. The slopes are 1½ to 1, and the inside slope is riprapped with limestone rock. The bottom and inside slope, under the riprap is puddled clay. It is 320 ft. wide by 420 ft. long and about 26 ft. deep. It holds 23 ft. of water which is equivalent to 18,000,000 gals. When it is full, the level of the water is about 237 ft. above low water mark in the river.

The city had always depended upon fire engines for fire pressure and there has never been a scarcity of water since the reservoir was completed. From a sanitary standpoint, however, the reservoir was not so satisfactory during the first years. The growth of algae became so troublesome that finally, in the year 1898, it was covered with a wooden roof to keep out the sunlight. The roof eliminated the algae but within eight years it was so badly decayed that it was falling into the water and causing a disagreeable taste and odor. It was therefore removed in 1906, and copper sulphate treatment has prevented serious trouble from algaecidal growths since that date.

Three eminent consulting engineers made an appraisal of the Quincy Water Works plant in 1903. Their reproduction value of the reservoir, including a land value of $13,325, was $60,114. Their estimate also included the fence surrounding the reservoir, a small cottage, the wooden roof and all pipe connections. The maintenance cost has been negligible.

Plant Equipment and Operation

With this large storage reservoir connected with the distribution system, at its highest elevation, it has been possible to develop the pumping and filtering plants on a one-shift basis. At the present time, the plant capacity is 6,000,000 gals. in 24 hours, which is the normal capacity of the filter plant. Since the city uses an average of only 2,000,000 gals. per day, the pumping plant is in operation only 8 hours per day and it is always operated at its most economical rate. When the pumping station is not in operation, the city uses water from the reservoir.

The pumping station was formerly operated with steam. Although it was operated on a one-shift basis, there were two engineers and a fireman on duty and considerable extra labor was required for handling coal. There was also a night watchman who did the janitor

Printed as insert to Municipal and County Engineering, Chicago, Ill., July, 1920.

work and had the boiler pressure up ready to begin pumping as soon as the engineers came on duty in the morning.

The value of the reservoir, as an adjunct to a water works plant was exemplified repeatedly during the years 1910 to 1915. During that period, the old pumping station and all of the old pumps were removed and a new building erected and new pumps installed. The old filter plant was also abandoned and a new one erected. In making changes in pipe connections from the old to the new, it was only necessary to fill the reservoir and shut down the plants until the changes were completed. A shut down of four or five days was easily arranged.

But the reservoir was not appreciated at its full value until negotiations were begun for the use of hydro-electric power from the Keokuk power plant. Having the reservoir with plenty of storage capacity made it possible to enter into a contract for off-peak power at a very satisfactory rate. A contract was made in 1914, for off-peak power for operating the pumping station and filter plant at 6½ mills per kw. hr. During the six summer months, the water department has continuous service if it is needed but during the six winter months, the power company has the right to discontinue the service from 2:30 p. m. to 6:30 p. m. each week day. Since eight hours' operation per day supplies sufficient water for the city, it has not been difficult to arrange the hours of pumping to suit the requirements of the off-peak contract. As a matter of fact, practically all of the water is pumped with electric power. Steam pumps have been maintained for reserve service but they have only been operated enough to keep them in serviceable condition. It has not been necessary to keep fires under the boilers.

Although the Illinois State Public Utilities Commission increased the power rate from 6½ to 7½ mills per kw. hr., on July 1, 1918, it is still a very desirable contract for the water department because the increase in the price of coal has been much greater than the increase in the power rate.

Only two men are now regularly employed at the pumping station. An engineer is on duty while the plant is in operation and the night watchman is still employed. Motor-driven centrifugal pumps are used and while they are not so efficient as crank and fly wheel steam pumps of the same capacity, the cost of installing them is only about 25 to 40 per cent. of the cost of steam equipment of the same capacity and they require much less floor space and head room and the cost of maintenance is comparatively low.

Service for High Districts

Reservoirs which are built on hills are very likely to be surrounded with residences which must have water service and fire protection, eventually. This has already taken place at Quincy but it was not a difficult problem to solve.

A 300,000-gal. elevated tank was erected on ground adjacent to the reservoir. A small booster pumping station was arranged to boost water from the reservoir to the tank. That portion of the distribution system which supplied the high district of the city was cut off and valved off from the reservoir pressure and connected with the elevated tank. Motor-driven centrifugal pumps were installed in the booster station. The pumps are started and stopped by means of pressure regulated automatic switches. A water works foreman who lives in the cottage at the reservoir attends to the oiling of the pumps and that is practically all the attendance the plant needs.

Since the pumps are under automatic control, the off-peak power rate could not be secured for them. Regular power rates are therefore paid but since this station handles, approximately, only 12 per cent. of all the water used in the city, it is cheaper to operate the booster station than it would be to put all of the water under the additional pressure at the main pumping station, if it could be done. The mains in the lower part of the city, however, are not strong enough to withstand greater pressure than they now sustain.

Reservoirs and Electric Power Interruptions

Electric power is subject to interruptions, especially if it is transmitted considerable distances. Lightning has caused occasional interruptions at Quincy but the storage reservoir, on such occasions, again demonstrates the desirability of having a supply of water in storage. The interruptions have never lasted more than three or four hours and there is always sufficient water in the reservoir to last two or three days.

Conclusion

Where a storage reservoir can be built at an elevation above the city, sufficient to furnish satisfactory domestic pressure, it will prove an economical investment; it will eliminate danger of water scarcity for fire fighting; it will provide emergency service in case of breakdown of pumping equipment. In fact, if a satisfactory reservoir can be built, there can be no convincing argument in favor of direct pressure.

THE IRON REMOVAL PLANT AT IOWA STATE COLLEGE, AMES, IOWA

By Charles Sabin Nichols, Professor of Sanitary and Hydraulic Engineering, Iowa State College, Ames, Iowa

In its development of a satisfactory water supply, Iowa State College has experienced difficulties similar to those encountered by any progressive community demanding conveniences in keeping with the trend of the times. Various sources of supply have been developed and abandoned as inadequate; and the distribution system has increased from a windmill supplying water to a wooden tank in one building, to modern pumping machinery, a water treatment plant, a 162,000 gal. elevated tank and mains serving all parts of the campus and that part of the city of Ames immediately contiguous. It is interesting to note the changing conditions necessitating alterations in the water supply and eventually requiring treatment.

Early Water Supplies

The first well, dug at the head of a spring in 1868, gave out within two years. Another one in a different location, dug 12 ft. in diameter and 30 ft. deep, and then bored 30 ft. deeper, was abandoned without striking water. In 1872 the board of trustees ordered the development of a spring on the college farm, a wise move, as the resulting supply was amply sufficient until the unprecedented drought of 1893-6 when wells went dry

throughout the community. It was necessary to close college in October, 1895, because of lack of water.

Careful engineering and geological studies prompted the recommendation of a deep well for quantity particularly. Appeal was made to the State Executive Council who realized the urgency involved and authorized the preparation of plans and specifications and the advertising for bids for a deep well. The contract was awarded, work begun in December, 1895, and the well finished in

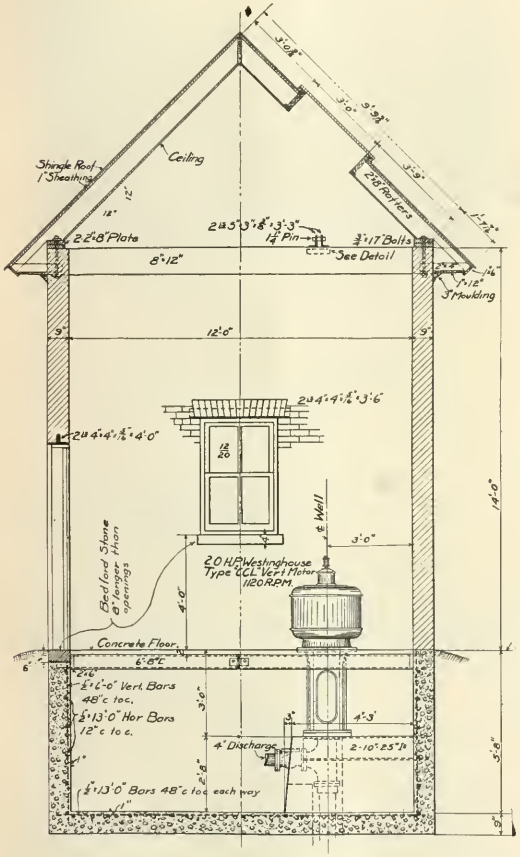


FIG. 1. TYPICAL WELL HOUSE, SHOWING MOTOR VERTICALLY CONNECTED TO GREGG MULTI-STAGE PROPELLER PUMP.

February, 1897, at a depth of 2,215 ft., having penetrated the Jordan sandstone and terminated in the St. Lawrence shales. Tests for quality and quantity met all reasonable requirements when compared with other deep well waters of Iowa. Some analyses appear in Table I, indicating the character of water to which many communities in the Central West are driven by necessity. This water would be considered intolerable in many sections of the country.

A steel tower and tank of 162,000 gals. capacity, 168 ft. high, was erected for more adequate fire protection, provided with water for both general and fire fighting

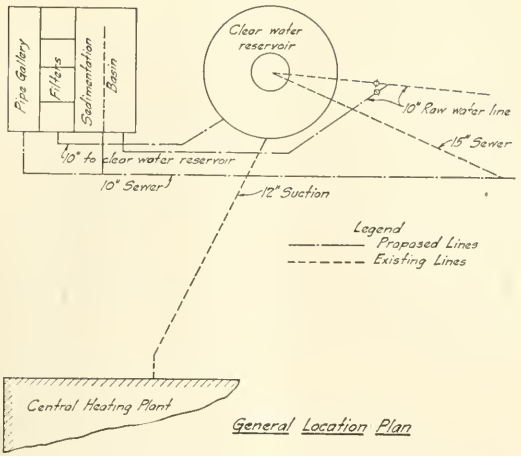


FIG. 2. GENERAL LAYOUT OF WATER TREATMENT PLANT AT IOWA STATE COLLEGE.

purposes. Maximum daily usage was then but 30,000 and again it seemed as though the college were amply gals. and the most liberal estimate for the future did not exceed 50,000 gals.

Unfortunately the future is never revealed in its entirety. About 1898 the college started the installation of a comprehensive sewerage system, with plumbing fixtures in all principal buildings. Two years later the unprecedented increase in student enrollment began, accompanied by active building in the vicinity of the college to provide adequate nearby quarters for the students. Soon a small municipality housing more than 2,000 students had arisen immediately adjacent to the college, and separated from the city of Ames by fully two miles. Water works became imperative for fire protection. As the city could not supply it, the college, to safeguard the lives of its students, shouldered the extra burden.

As a consequence the deep well supply soon proved meager, and frequent breakdowns in the pump introduced

FIG. 3—INTERIOR VIEW OF OPERATING FLOOR AND FILTERS. SHOWS FLOOR STANDS, LOSS OF HEAD GAGES, AIR BLOWER AND PIPING, SWITCHBOARDS AND CHEMICAL APPARATUS.

too dangerous an element of unreliability. A supplementary shallow well was sunk and equipped with an electrically driven triplex pump, but its assistance soon became insignificant. By 1906 it became necessary either to sink another deep well with its attendant large initial and heavy up-keep expense, and unreliability, or to seek an entirely different source. The water-bearing gravels of Squaw Creek bottom along the east side of the college grounds promised an unlimited quantity of water, though heavy in iron. This source seemed to offer the best solution for an abundant water supply, so a well was sunk about 100 ft. through the gravel and equipped with electrically driven centrifugal pump. To date three wells have been sunk, each one housed as shown in Fig. 1. All are now equipped with electrically driven multiple stage

Increasing criticism made imperative the elimination of the iron. Plans were prepared for a special aerator, in which to precipitate the iron and keep it out of the mains. This was built in 1908 and for some time proved quite effective, but with increasing volumes of water pumped, time for sedimentation was correspondingly reduced, and eventually most of the iron remained in suspension and found its way into the mains.

By 1913 the situation became so intolerable that the college authorities instructed the Dean of Engineering to investigate means of removing the iron. Professor Morris I. Evinger, then in charge of sanitary engineering of the college, was called into consultation and an investigation was inaugurated to determine the best method of treatment. Considerable laboratory work was done,

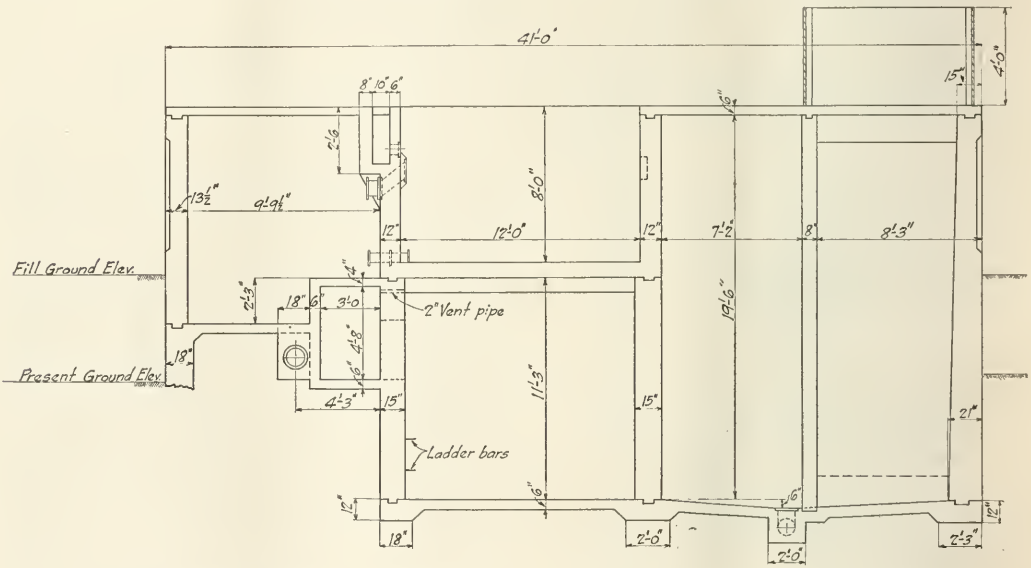


FIG. 4. SECTION THROUGH SEDIMENTATION BASIN, FILTER, CLEAR WELL AND PIPE GALLERY.

Gregg propeller pumps extending the full depth of the wells.

Iron Causes Trouble

As was anticipated, the iron caused trouble from the start. Contact with air precipitated large quantities of oxid, greatly discolored the water, plumbing fixtures and cooking utensils, introduced complications in culinary and laundry operations, and clogged hydrant stems, small service pipes, valves and other parts of the water works system. The natives eventually became trained to drink the water without holding their noses and closing their eyes, so long as it was thin enough to run, but strangers often suffered the agonies of thirst rather than partake. Dr. Wiley, eminent pure food specialist, once refused to drink it when offered to him on the college platform, and the suspicion yet prevails that he involuntarily departed from his set address to orate upon the unsymmetrical development of an otherwise enlightened community which was satisfied with an unwholesome water.

several plants were visited, and all available trade literature and standard plans were studied. The resulting recommendation favored a treatment combining aeration, coagulation, and gravity rapid sand filtration as best suited for this case. Professor Evinger was instructed to proceed with the preparation of plans and specifications and estimate of cost. The Legislature granted the asking of $15,000 to construct the plant.

Upon their completion, the plans and specifications were presented to the building committee of the Iowa State Board of Education for approval. Realizing the importance of the undertaking, the committee requested satisfactory operating guarantee, backed by financial responsibility, and to insure this ordered the inclusion of a provision for alternate bids on plans submitted by reputable filter manufacturing companies.

Bids were received in August, 1915. The college superintendent of grounds and buildings was ordered to construct the basins, building and sewers, according to

the plans of the Pittsburgh Filter Manufacturing Company, successful bidders on mechanical equipment. The general ground layout shown in Fig. 2, closely approximates that originally proposed, but the plant details were

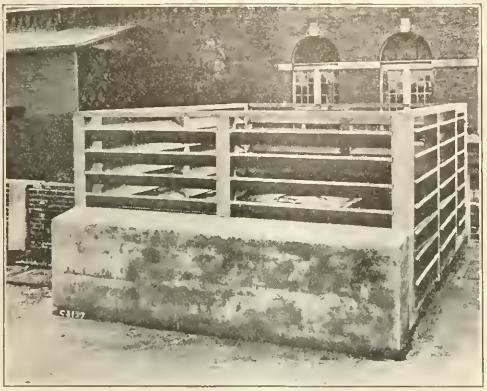


FIG. 5—VIEW OF AERATOR.

materially altered to conform to the Pittsburgh Filter Manufacturing Company's special equipment.

Essential Features of the Iron Removal Plant

The essential features of the plant are an aerator, a coagulation and settling basin, providing 4 hours detention at present and 2 hours on full capacity, four gravity filters of 311,000 gals. per 24 hours, normal operating capacity each, and a clear water well of about 40,000 gals. capacity. The old aerator of about 100,000 gals. capacity is used as an additional clear water reservoir and as a suction well for the service pumps.

In design and operation, economy and simplicity were paramount. The plant is arranged to operate automatically. By means of the raw water inlet control valve, the water in the coagulating basin may be maintained at a constant level, and the proportional chemical feed regulator assures a chemical dosage in proportion to the volume of water entering the basin. The filters are controlled by individual hydraulic throttling valves all operated by a master controller. These valves will automatically throttle the filter when the water in the clear well reaches a predetermined level, thus preventing upward pressure of water on the filter floors. Thus, when the clear well is full, the filters will be automatically shut off, the water in the coagulation basin will rise until the inlet controller shuts off the supply to it; at the same time the flow of chemical will be cut off and the entire plant will be at a standstill. When the water in the clear well drops, the filter will open automatically, and the flow of raw water and chemical will begin in exact proportion to one another.

In operation the water is pumped to the aerator, shown in Fig. 5, where the chemical is introduced. It

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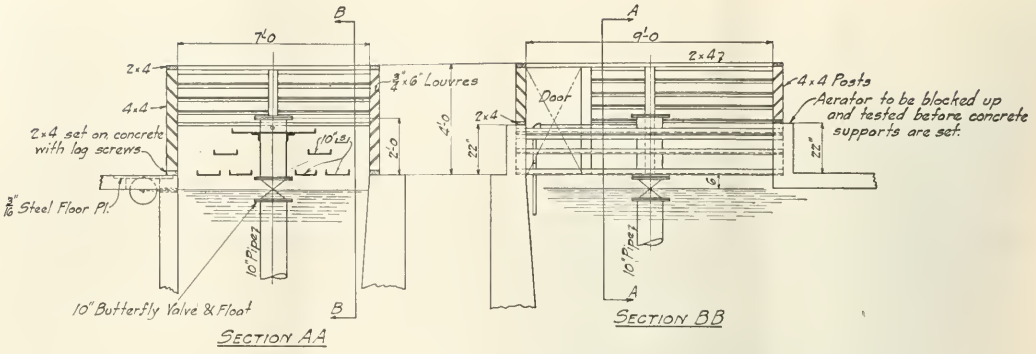

FIG. 6. DETAILS AND GENERAL ARRANGEMENT OF AERATOR.

then passes over and under a series of baffles in the mixing rack, flows through the coagulation basin, over a weir into a trough running along the front of the beds and connecting with them through 6 in. gate valves. It filters down through the sand and gravel, into the collecting grid on the bottom leading to the clear well which is connected directly with the surface reservoir. From this reservoir it is pumped into the mains.

Each of the four filter tanks is 12 ft. long, 9 ft. wide and 8 ft. deep, built as a monolith and practically watertight when full. Only three of the four beds are now equipped, the fourth one being held in reserve. With the present pumpage of about 500,000 gals. per day, the three beds operate at comparatively light load, and require a minimum of washing.

Each filter is equipped with an overflow trough for distributing the incoming treated water and for removing evenly from all parts of the bed the water used for washing. These troughs connect both with the raw water inlet and with the sewer. They are constructed of steel plates in such form as to prevent as much as possible the loss of sand during washing.

The collecting and washing system is shown in Fig. 7. The main collector, running longitudinally on the bottom of the filter tank along its center, is a heavy cast iron manifold, bolted together with machine bolts. On each side of the manifold tributary pipes, 2 ins. diameter, and 6 ins. center to center, extend to the side walls of the tank. These pipes are capped on the end. Into the manifold and lateral pipes are screwed bronze metal screens spaced 6 ins. each way. These screens are 1¾ in. in height and are so constructed that they can be taken apart without displacing them. The entire collecting system is concreted in up to the flanges on the screens.

Above the collecting grid is placed 10 ins. of gravel,

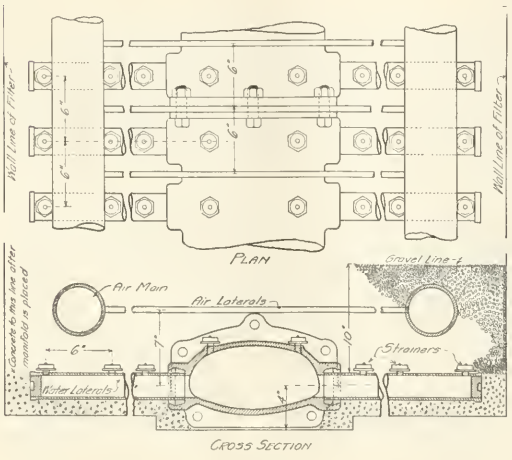

FIG. 7. DETAILS OF WATER AND AIR MANIFOLD SYSTEMS.

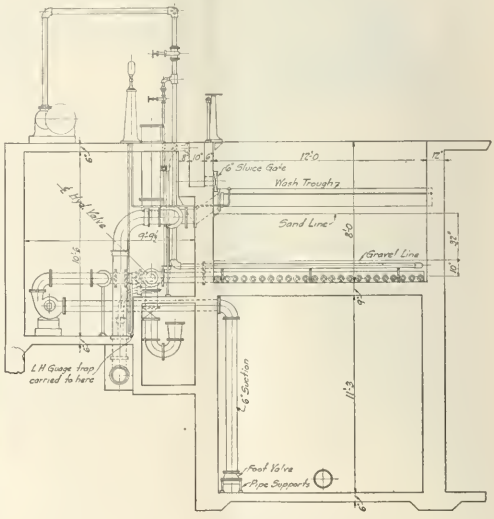

FIG. 8. SECTION THROUGH FILTER, CLEAR WELL, PIPE GALLERY AND OPERATING FLOOR, SHOWING EQUIPMENT IN PLACE.

and on top of that is 30 ins. of filter sand. The gravel is composed of clean, rounded, silicous pebbles screened from material of a sandy nature, and free from splinters, flat pieces, limestone or other friable material. It is of such size that all will pass a screen having a clear mesh of ⅝ in. and be retained on a screen having a clear mesh of 3-16 in. The sand is a hard, silicous material, specially selected and screened, free from loam, dust and perishable matter, and contains not to exceed 5 per cent of flat or laminated particles. It has an effective size of 0.334 m.m. and a uniformity co-efficient of 1.4

Just above the collecting manifold is the air wash distributing system, also shown in Fig. 7. It consists of galvanized wrought iron pipes extending along three sides of the filter wall and connected across from side to side by ½-in. brass tubing, spaced 6-in. centers. The brass lateral pipes are perforated on their under side with 1-16-in. drilled holes through which air is admitted under pressure. The entire system is so arranged that no pipe will have a dead end; this insures even distribution of air over the entire filter bed area, and prevents clogging of the air pipes. A connection to water pressure enables the attendant to flush out the pipes after the application of air.

Although aeration and coagulation settle out a large amount of iron in the coagulation basin which can be flushed into the sewer direct, still enough carries over onto the beds to gradually clog the surface and necessitate washing. With a filtration of 500,000 gals. in 24 hours, using three beds, or an average rate of filtration of about 1 gal. per minute per square foot of filter surface, each bed has to be washed once in 36 hours. The loss of head caused by clogging is indicated by the loss-of-head gages. The piping can be traced in Fig. 8. Each gage is mounted on a separate cast iron stand

FIG. 9—SHOWING AGITATION BY AIR TO BREAK UP THE SURFACE SEAL.

placed in front of the filter, as can be seen in Fig. 3. The gages are connected on one side with the raw water conduit, and on the other side with the effluent pipe. By means of a vacuum the difference in head is indicated by a mercury column which rises alongside the graduated scale. This scale is tested and adjusted properly to indicate the loss of head due to sealing of the filter surface

(Continued on page 34)

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(Continued from page 31)

for each of the beds, and the point determined at which they should be washed.

When washing a bed, the raw water inlet to the bed is closed and the water in the bed is allowed to filter until the surface is somewhat below the top of the over-

FIG. 10—VIEW OF CHEMICAL MIXING TANKS AND TIPPING TANK FOR PROPORTIONAL FEED.

flow trough. The effluent valve is then closed and air is applied by a blower through the air wash manifold at a pressure of 3½ to 4 lbs. per square inch for 5 or 10 minutes. This agitates the surface of the filter as shown in Fig. 9 and breaks the gelatinous seal which has formed. The air is then shut off and filtered water is forced up through the collecting system at about 5 lbs. per square inch for a period of 5 or 10 minutes. The pressure of wash water is indicated on a gage. This water carries with it the loosened surface deposit into the overflow trough to the sewer. The wash water is then turned off the sewer valve closed, the air distribution system flushed with filtered water and wasted into the sewer, the raw water turned into the bed, the effluent valve opened and normal operations resumed.

The washing operation requires from 1,100 to 2,000 cu. ft. of free air and from 8,000 to 10,000 gals. of filtered water.

The air blower is the Root make, and has a capacity of 225 cu. ft. of free air per minute under a pressure of 3½ or 4 lbs. per square inch. It is connected with a 7½ H. P. 3 phase, 60 cycle, 220 volt General Electric Company motor of the squirrel cage type.

The wash water pump is a Platt Iron Works 8-in. double suction, side cover centrifugal, directly connected through flexible coupling with a 15 H. P. General Electric Company slip ring, variable speed motor. The pump is guaranteed to deliver 1,080 G. P. M. at 1,150 R. P. M. against a pressure of 10 lbs. per square inch.

The motors for air compressor, wash water pump and chemical mixer are controlled from a switchboard and starting boxes.

The effluent pipe from the filters discharge through "U" tubes into a concrete duct in the filter gallery and connected with the clear well through a port at one end, (see Fig. 8.) The valve over the "U" pipe orifice is hand operated and can be set for any maximum rate desired. Up to this maximum the rate of filtration of each filter is controlled by a hydraulic throttling valve, and all are governed by a master controller. The master controller is a large cast iron chamber connected with the raw water conduit supplying the beds so that their water levels will correspond. In the chamber is a float, weighted to submerge 12 ins., connected by a lever arm to a pilot valve which operates the hydraulic throttling valves on the individual filter effluent pipes, under college pressure. Thus, as the rate of pumping increases the water will rise in both raw water conduit and controller chamber. The float will rise, carrying with it the end of the lever arm to which it is connected. This so operates the pilot valve that water pressure is transmitted to the bottom of the effluent throttling valves, tending to open them and allow more rapid flow of water. If the pumping rate decreases the operation is reversed; the float lowers and the pilot valve transfers pressure to the upper side of the throttling valves tending to close them and decrease the flow.

On the effluent pipes are also butterfly valves with floats so set that when the water rises in the clear well to within 6 ins. of the filter floor the valves will close and filtration cease. A similar valve also controls the main raw water inlet pipe so that when the water in the raw water basin reaches a certain height the valve will close. Thus, if the pumpage to the filter plant exceeds the usage, the clear water well will fill and filtration will be automatically stopped. Water will then back up through the plant until it reaches the level in the raw

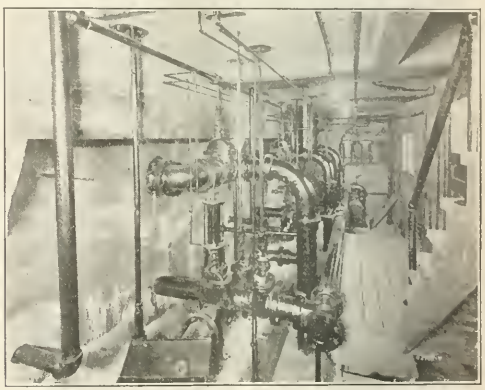


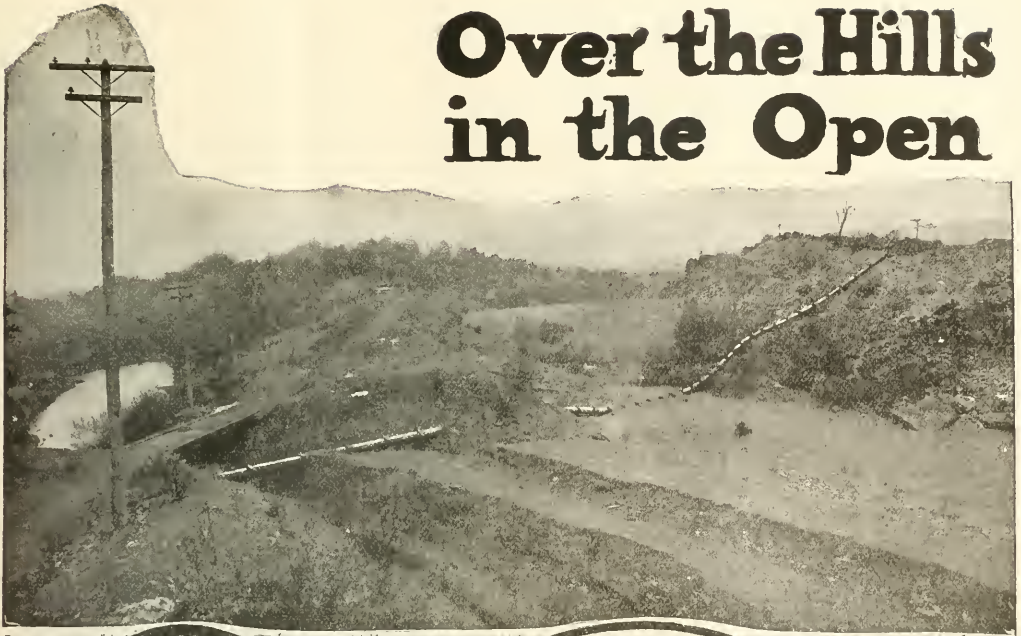
FIG. 11—VIEW OF PIPE GALLERY SHOWING SIMPLE LAYOUT.

water basin at which the inlet valve closes. The whole plant will then be idle until the water in the clear well has lowered sufficiently to open the butterfly valves in the effluent pipes when filtration will be resumed; and when it has lowered the water sufficiently in the raw water basin the inlet valve will open, the pumps will start and the raw water will be admitted.

In actual operation, however, the college does not rely upon the valve controlling the main raw water inlet

(Continued on page 36)

Over the Hills in the Open



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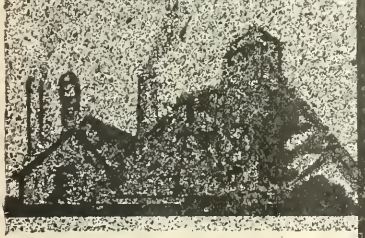

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(Continued from page 34)

pipe. The float is connected directly with an indicator in the pumping station so that bell will ring when the water in the raw water basin reaches the height at which the valve would be closed. The attendant then stops and starts the pumps as required. It was feared that the valve might be closed in the supply pipe without stopping the pumps, thus causing damage.

Automatic regulation is likewise extended to the chemical solution plant, see Fig. 10, which is so intimately connected with the entire operation as to feed a known amount of chemical in exact proportion to the amount of raw water going to the coagulating basin.

The chemical solution plant consists of two cypress tanks 3 ft. in diameter by 4 ft. deep, each equipped with a motor driven paddle to maintain uniformity in the chemical solution, and with a water gage to indicate the height of solution in t hetank. Both tanks connect, through screens and brass pipe to an automatic dosing device as hereafter described.

A cast iron cylinder well is connected with the raw water inlet pipe so that the water level in the well will correspond with that over the orifice of the inlet pipe. In the well is suspended a brass float connected by a wire running over pulleys, with a cast iron, enamel lined, tilting tank designed to discharge the chemical solution through an arm into an enamel lined receiving funnel connected with the pipe leading to the chemical diffuser under the aerator. In the tilting tank is also a brass float which operates a brass valve on the line from the chemical solution tanks. As increased pumpage raises the water over the orifice of the raw water inlet pipe, the float in the well will rise. This will lower the arm of the tilting tank and more chemical will flow, thus lowering the liquid in the tilting tank. Its float in dropping will open the valve on the supply pipe asd allow more solution to flow into the tilting tank. When pumping stops the float in the well will drop, the arm on the tilting tank will rise sufficiently to prevent the flow of chemical, and the float in the tilting tank will rise and close the valve on the feed line.

In spite of automatic control throughout, which ordinarily complicates the mechanism, the arrangement is very simple. Pipes and valves are readily accessible in the pipe gallery as shown in Fig. 11.

All valves for operating the filters are connected by extension stems with floor stands having hand wheels showing by raised cast letters the valve each operates and the direction of opening. All gate valves are of the double gate pattern suitable for a working water pressure of 50 lbs. per square inch on low pressure lines, and 100 lbs. per square inch on high pressure lines. All valves have stuffing boxes with bolt followers.

The Pittsburgh Filter Manufacturing Company furnished the following guarantee:

"Upon completion of the work, the contractor shall furnish a competent man to start the plant who will conduct the operation of the plant for a period of ten (10) days, during which time the purchaser may have the water tested and analyzed to determine the degree of purity obtained and said degree of purity shall be as follows:

The filtrate shall not show acid reaction. The filtrate shall be clear, bright, and practically free from color, turbidity, or matter in suspension and shall be supplied at the rate of 311,000 U. S. gals. per 24 hours for each filter when the filter is operated at normal capacity.

The filtrate shall not contain iron in amount to exceed five tenths of one part per million.

"The amount of wash water used for washing the filter shall not exceed an average of 4 per cent (4%) of the total amount of water filtered.

"The contractor will replace within one year after the plant has been operated, any material proving defective due to mechanical defects or poor workmanship.

"All guarantees given above are conditioned on the following: That the filter plant be operated in accordance with the contractor's instructions and that a proper quality and quantity of coagulant be used.

"It is assumed that the above given guarantee can be accomplished by depending solely upon the use of aeration without the addition of lime or alum, but this cannot be determined without operating the plant. The contractor therefore reserves the right to use alum or lime or both chemicals in order to meet the guarantees."

Labor and material troubles delayed completion so that operation was not started until January, 1917. The operating results during the first month of tuning up and testing are shown in Table II, indicating the efficiency of the plant for the removal of iron in solution. The total cost was approximately $15,000, of which $6,600 was for mechanical equipment.

On account of the high cost of aluminum sulfate, hydrated lime is used for coagulant, a dosage of 40 lbs.

(Continued on page 39)

TABLE I—ANALYSIS OF IOWA STATE COLLEGE DEEP WELL WATER, COMPARED WITH ANALYSES OF WATERS FROM OTHER DEEP WELLS IN IOWA

(Parts per Million)

	College	Boone	Cedar Rapids	Centerville	Davenport	Sioux City
Mineral						
Silica (SiO_2)	3.000	11.858	2.571	10.285	8.571	16.428
Alumina (Al_2O_3)	7.000	10.000	17.857	3.000	3.143	11.000
Ferric Oxid (Fe_2O_3)	.....					
Lime (CaO)	49.300	217.285	98.000	367.571	28.000	316.571
Magnesia (MgO)	24.300	107.143	51.714	149.143	9.143	120.571
Potash (K_2O)	.....	.428	.....	Trace	.....	.....
Soda (Na_2O)	526.800	546.858	122.000	1,017.143	548.857	299.428
Chlorin (Cl)	203.800	152.858	.428	388.571	273.429	84.143
Sulfur Trioxid (SO_3)	429.700	862.857	172.857	1,634.000	229.000	716.000
Carbon Dioxid (CO_2)	118.800	194.285	248.857	66.429	157.571	146.571
Water in combination	17.600	43.428	51.143	13.714	14.286	.....
Totals	1,380.300	2,147.000	765.427	3,639.857	1,272.000	1,710.712
Incrustants	148.600	790.000	311.000	1,324.000	84.250	1,037.000
Sanitary						
Free ammonia	1.200	1.400	.862	.978	1.100	1.250
Albuminoid ammonia	Trace	.015	.016	.020	.005	.015
Solids	1,258.000	2,047.140	592.900	4,132.140	1,192.850	1,617.140
Nitrites	Trace	None	.800	4.800	None	Trace
Nitrates	Trace	None	.160	None	None	Trace
Oxygen consumed	None	.740	1.000	2.480	.985	1.85

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(Continued from page 36)

per day for a pumpage of about 500,000 gals., giving satisfactory results.

The cost of operation of the plant is probably somewhat lower than would obtain in some localities. It is estimated to be approximately $6.13 per million gallons filtered, divided as follows:

Item	Cost per Mil. Gal.
Attendant, ½ time @ $41.25 per mo.	$2.68
Lime @ 1¼c per lb.	.95
Oil, waste, etc.	.15
Electricity @ 5c K. W. H.	2.10
Wash water @ 5c per 1.000 gals.	.25
Total cost	$6.13

A water usage of 500,000 gals. per day would be common for Iowa cities of 5,000 to 10,000 population. Assuming 5 to a family, and only 75 per cent connections, the cost per connection for filtration would vary from 75 cts. to $1.50 per year. Supplementary liquid chlorine treatment to kill pathogenic bacteria would cost but 5 or 10 cts. a year more. This introduces no financial burden, and is certainly cheap insurance against water borne diseases.

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Filtration of public water supplies is not very common in the midwest states now, but the water situation is such in most localities that many towns and cities will eventually be forced to adopt a source of supply which requires treatment of some sort, and filtration must of necessity enter largely into the process. The public and the public officials in such communities must be taught to recognize in filtration and associated operations the solution of their water difficulties, and to appreciate that the use of chemicals, against which there is at present some deep-seated prejudice, is beneficial rather than harmful.

TABLE II—DAILY TESTS ON COLLEGE WATER FILTRATION PLANT
January 18 to February 17, 1917

	Original Water		Aerated Water		Effluent	
	Well No. 1	Well No. 2	Well No. 1	Well No. 2	Well No. 1	Well No. 2
1. Aeration. No further treatment. Av. of 5 days.						
Halfbound CO_2	147.60	135.70	145.80	137.00	144.006	136.2
Dissolved Oxygen	.11	.05	5.49	5.62	7.090	8.27
Iron in Solution	7.92	6.45	.64	.28	.191	.019
2. Aeration; 20 lbs. Lime per 24 hrs. Av. of 3 days.						
Halfbound CO_2	145.50	.....	144.00	.....	142.4	.....
Dissolved Oxygen	.37	.....	5.68	.....	5.55	.....
Iron in Solution	6.07	.....	0.61	.....	.02	.....
3. Aeration, 50 lbs. Lime per 24 hrs. Av. of 6 days.						
Halfbound CO_2	148.30	137.70	148.70	139.80	149.600	138.200
Dissolved Oxygen	.02	.02	5.22	5.35	5.560	8.150
Iron in Solution[1]	7.29	7.24	.20	.18	.037	.028
4. Aeration; 20 lbs. Aluminum Sulfate per 24 hrs. Av. of 3 days.						
Halfbound CO_2	147.50	135.30	145.20	135.00	144.80	134.60
Dissolved Oxygen	.12	.01	5.20	5.61	6.73	8.02
Iron in Solution	7.53	6.60	.53	.10	.020	.006
5. Aeration; 40 lbs. Aluminum Sulfate per 24 hrs. Av. of 3 days.						
Halfbound CO_2	147.80	135.50	147.40	135.60	144.800	134.200
Dissolved Oxygen	.12	.05	5.47	5.55	7.400	7.420
Iron in Solution	7.60	6.70	1.00	.50	.028	.012
6. Aeration; 20 lbs. Aluminum Sulfate per 24 hrs. Av. of 3 days.						
Halfbound CO_2	145.80	131.10	144.10	135.10	143.900	133.70
Dissolved Oxygen	.07	.06	5.50	5.67	7.280	7.96
Iron in Solution	7.35	6.60	1.05	2.22	.047	.02
7. Aeration; 40 lbs. Lime per 24 hrs. Av. of 3 days.						
Halfbound CO_2	.....	135.50	147.00	131.00	147.40	135.00
Dissolved Oxygen	.....	.08	5.07	5.47	5.94	7.88
Iron in Solution	.....	7.20	.80	1.43	.13	.07
8. Manganese; average for all treatments	.214	.180	.....	.....	.214	.160

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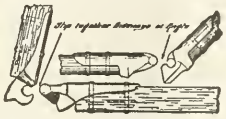

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Construction News and Equipment

EXCAVATING BASEMENT UNDER FIVE-STORY BUILDING

Digging the basement for a building after five stories had already been constructed was the unusual work done by a Smith Excavator and Loader for the Walter W. Oeflein Company in connection with the building of the big factories for the Wisconsin Food Products Company at Milwaukee.

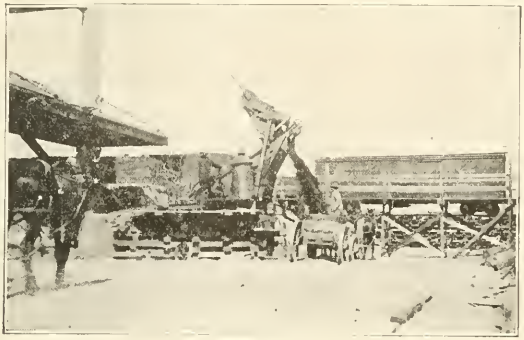
This building was started last November in the midst of a prolonged cold snap which left the ground in a solid frozen state making extensive excavating a physical impossibility. Instead of delaying the construction until the ground became soft enough to dig, the contractors decided to dig only space enough for the footings and columns and leave the bulk of the excavating until a later date. The entire space to be excavated measured approximately 300 ft. by 160 ft. and at a depth of about 7 ft.

The location of each column was marked out and a fire built on the spot to soften the ground. A hole was dug just big enough to permit pouring of the columns and the rest of the structure was continued in the usual manner.

The fact that the space between the top of the ground and the bottom of the floor of the first story was less than 5 ft. in some places presented an unusual excavating problem. A steam shovel was impossible because of the low clearance and hand shoveling would have been recklessly inefficient and costly.

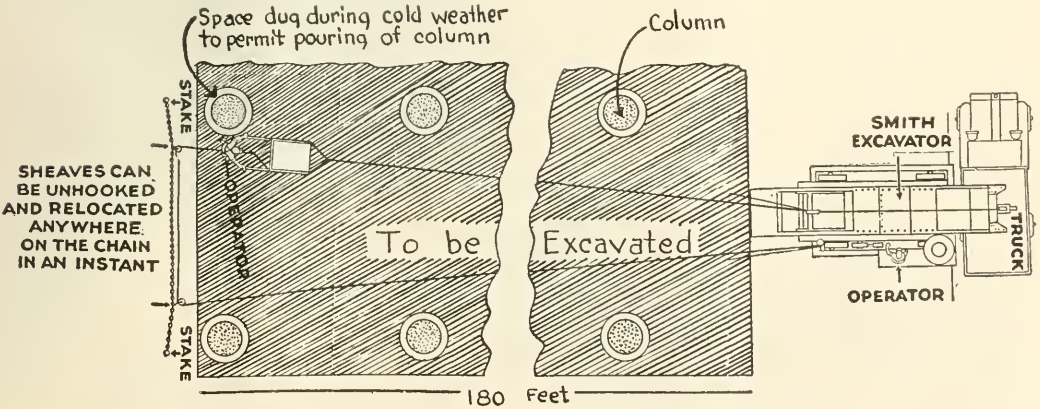
The Smith Excavator and Loader was particularly adapted to the work because of the principle upon which it operates. The dragline which brings the dirt up to the machine requires no more clearance than that required by a man guiding the slip.

The Excavator and Loader was set at the edge of the building in such a position as to give a straight run between two rows of columns. At a point, 180 ft. away from the machine, two stakes, 20 ft. apart, were driven. A heavy chain was stretched between these stakes. Upon this chain two sheaves were hooked, either of which could be unhooked and relocated anywhere on the chain to change the path of the excavation. As shown by Fig. 1, a heavy cable passed from the hoist drum on the machine, then to the digging slip, then through both sheaves, and back to the retrieving hoist drum on the machine.



SMITH EXCAVATOR DUMPING SLIP INTO WAGON.

As the dirt between one row of columns was removed the Excavator was moved to the center line of the next row. Only two men were necessary for complete operation, one man at the digging slip and the other operating the machine. Only a limited number of trucks were available which caused the machine to lose considerable



PLANT LAYOUT FOR EXCAVATING BASEMENT UNDER FIVE-STORY BUILDING.

time between loads but in spite of this condition the dirt was moved at the rate of 30 cu. yds. per hour or 300 yds. in a 10 hour day.

On the side upon which the machine was located was a depression in the ground running the full length of the side of the building and extending about 6 ft. below the basement level of the building. This complicated the digging problem somewhat but it was overcome by removing the wheels of the Excavator and building a crib platform upon which the machine was elevated and mounted.

This work is most interesting and almost epochal because it opens up new possibilities for making construction work a year 'round proposition.

The Excavator and Loader referred to above is manufactured by the T. L. Smith Company, Old Colony Building, Chicago, Ill.

COST PLUS CONTRACTS FOR WATER WORKS AND OTHER MUNICIPAL CONSTRUCTION

By George W. Fuller, Consulting Engineer, 170 Broadway, New York City.

Prior to the Great War, the "cost plus" form of payment on contracts in the water works field was limited to a relatively few large projects built as a whole under this type of contract for private corporations and to numerous small unexpected features of enterprises executed under municipal contracts where "extra work" clauses were attached to either lump sum (bulk) or unit price contracts.

During the war a large amount of emergency government work which had to be performed in the shortest possible time gave great impetus to the "cost plus" form of contract.

The unstable condition of the market for labor and materials now found in many places causes this form of handling construction work to come up repeatedly for discussion. Such discussion results from the necessity for finding expedients to meet present emergencies which, while not comparable with those of the war period, are nevertheless present during this reconstruction period to an extent which perhaps is not generally recognized.

At this time when contractors are sorely puzzled to know how to bid on construction materials on which quotations are made by dealers only on the basis of changes in price contingent on the actual date of future deliveries and when labor is uncertain in quantity and of reduced and somewhat uncertain efficiency as to output of work per hour, it is obviously necessary to look conditions squarely in the face. Add to this the difficulties in transportation of construction materials and the loss incident to the contractor having a substantial payroll for labor when materials to work with are lacking and it is readily seen that this is a time for considering fundamental principles in handling construction work to an extent that would not be of interest under normal conditions.

The writer believes that water works construction which reasonably can be deferred should not be contracted for at present. In the case of many water works projects the existing works can with propriety be patched and overhauled in a manner similar to that adopted by the individual who under present stress makes use of old and patched clothes. There are some water works betterments which cannot be postponed owing to the fact that this expedient has been resorted to for so long that further postponing means positive disaster along various lines associated with a water famine.

Much needed work is now impossible of accomplishment due to the inability of labor agencies to supply men, of manufacturers to supply material and of transportation facilities to deliver goods. Competition between owners will only increase the already serious aspect of obtaining material for construction work which it is important to have done in the near future.

Some water works construction must go forward. With conditions as they are at present the contractor, if he bids on a lump sum or unit price basis, is bound to name a price which in his opinion will protect him from loss and if possible assure a reasonable return on his capital investment and for the work of himself and his organization. Under these circumstances it is important to discuss briefly the cost plus form of contract with a view to seeing if the burden of uncertainty in some respects cannot be shifted from the contractor to the owner to the advantage of all concerned. In fact, if construction work is to go forward there are some projects where such steps seem imperative.

Legality of Cost Plus Contract

Before pointing out briefly the advantages and disadvantages of the cost plus form of contract, it is well to recall that there is serious doubt as to the legal right of municipalities, in some localities at least, to enter into such contracts. State and provincial laws and municipal charters usually call for the letting of contracts for public works by open competitive bidding for all work in excess of certain specified amounts. Also such laws provide, almost without exception, that contracts shall not be made in sums in excess of appropriations duly authorized and in some cases above the estimates of the engineer of the governing body.

As regards the first restriction the intent is obviously to take advantage of competition in making sure of proper market prices.

The second restriction is a check on total estimated costs by actual bids for the work. In the absence of preliminary bidding, work might be started when appropriations are insufficient for completion, or opportunities might be lost for reducing costs by subsequent lettings through correction of misunderstandings as to construction procedures.

Stabilization through such restrictions should not be abandoned unless there is a great emergency.

Cost Plus Contracts

There have been and always will be certain construction problems in which some means of payment in the form of actual cost plus a percentage or lump sum is legitimate and desirable, if not necessary. This is true even with lump sum contracts in which certain features may be indefinite or subject to changes regarding the character of the work. Cost plus provisions for extra work, or supplementary contracts based on such arrangements or estimates, are also pertinent where sufficient investigation previous to a letting is undesirable or too

expensive in time or money for the advantage gained, such as extensive street openings to locate existing structures, and also in cases where the owner desires to retain complete control of the work regardless of the cost.

It is claimed that under the cost plus method a contractor has little incentive to keep down the cost of the work. This is frequently true of the cost plus percentage but need not be true of the cost plus lump sum type. In any case it must be remembered that a contractor who will deliberately be inefficient on a cost plus project is equally sure to attempt improper or inadequate construction on lump sum or unit price agreements.

Types of Cost Plus Contracts

There have been a great many variations of the cost plus contract applied to construction work but the more important are:

1. Actual proved cost with labor and material furnished without restriction by the contractor—plus a fixed percentage or lump sum to represent profit, supervision, financing, use of tools and plant, or any or all of these.

2. Actual proved cost of labor furnished by the contractor and with materials furnished by the owner, with a fixed percentage or lump sum as above.

3. Actual proved total cost for specified work plus a percentage for specified or unexpected extra or unforeseen work in connection with lump sum or unit price contracts.

4. Actual proved total cost to the contractor plus a sliding scale fee and upset maximum fee.

5. Actual proved total cost to the contractor plus a fixed charge and fixed construction fee.

Advantages Claimed for Cost Plus Contracts

1. The work may be started at any time and is not dependent on the prior completion of the plans.

2. The owner may radically increase or decrease the quantities during construction, with lump sum fees subject to review.

3. The owner may change the kind of construction during the progress of the work.

4. The contractor will not try to skimp the job as is often done after finding himself losing under lump sum or unit price contracts.

5. There is less need of having accurate preliminary estimates. In unit price contracts the preliminary estimate is often so approximate as to cause the contractor to gamble on some of the items, with resulting disappointment to the owner in the ultimate cost of the work. Such procedures sometimes cause an unfair result either to owner or contractor or both.

6. Unit price or lump sum bids require a set of specification definitions which are not always clear and are sometimes deficient and sometimes overlapping. Such ambiguities may lead to arguments and variations in cost which result in claims and suits for extra work.

7. Cost plus contracts may save the owner the money which the contractor usually adds to his lump sum or unit price bid to cover the complete but actually infrequent enforcement of material tests which cause him delay and expense, or necessitate the carrying of a large stock, entailing interest charges, storage space, rehandling etc.

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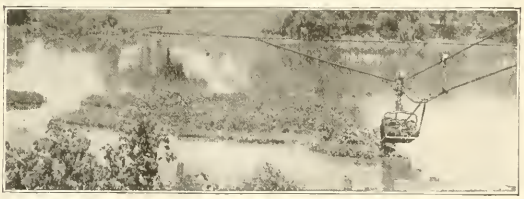

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8. Cost plus contracts do away with the substantial sums usually added in lump sum or unit price contracts to cover the following uncertainties: (a) Weather; (b) Foundations; (c) Changes and shortages in labor market; (d) Changes and shortages in material market; (e) Delayed deliveries of materials.

9. For cost plus work it is the contract and not the specifications which is the crux of the matter from both the owner's and contractor's viewpoint. The writing of the contract is more simple than the writing of the specifications.

10. Cost plus contracts tend to promote cooperation between the owner and the contractor.

Disadvantages Claimed Against Cost Plus Contracts

1. There is no way of determining the approximate cost in advance and this upsets budgets where definite appropriations have been made or are required.

2. Competition—the key to efficiency—is killed.

3. Greater opportunity is offered for favoritism on the part of the owner's representative.

4. Where the same contractor has several jobs, the lump sum and unit price contracts will get the good workmen and the cost plus contract will get the drones and misfits.

5. A large general contractor often takes a job on the cost plus basis and sublets it to several smaller contractors on a lump sum or unit price basis. In making the sub-contractors complete the work on the latter basis the general contractor often treats them unfairly while he himself may be receiving a substantial profit for doing little or nothing.

6. Should work be started before plans are completed, many errors may have to be straightened out in cases where competent engineers would avoid them if given an opportunity to get out a complete set of plans and accurate estimates of quantities.

7. Engineers are tempted to be less thorough in their work when they know that there will be no comeback at them on account of extras resulting from their failure to have plans and specifications complete when needed. With cost plus contracts it may simply be a matter of correcting an error or supplying a deficiency when discovered, but the cost is there just the same although it may not appear as an "extra."

8. Engineers or other representatives of the owner must do an immense amount of accounting and clerical work in checking payrolls, material bills, etc., and expend much time and energy in expediting the delivery of materials.

9. A premium may be put on extravagances and waste by giving unscrupulous contractors and engineers a chance to take advantage of the owner.

10. The contractor may procrastinate in securing, if not refuse to secure promptly, adequate tools and equipment as to type and number.

11. A combination of the above disadvantages, although no one by itself may be sufficiently pronounced to permit the owner successfully to obtain relief, may cause grief for the owner, unless protected by a maximum fee to the contractor, and by the assured adequacy of the latter's organization and equipment.

Pre-War Status of Cost Plus Percentage Contracts

Much large construction work was and is done by railroads and other corporations in this way but this is done usually because these corporations, unlike municipalities, are legally able to select competent contractors with efficient organizations and equipment to work under the immediate direction of a skilled and alert staff of the owner who for the most part purchases supplies and material direct. The Grand Central Terminal in New York is a case in point. Much of the work was first awarded to a contractor on a unit price contract but it was completed under a cost plus agreement.

There can be no question that some work can be as economically and efficiently done under the cost plus basis as in other ways. But in the water works field such work appears to form the exception rather than the rule under peace time conditions.

Army Contracts for Construction Work

One of the best examples of cost plus percentage agreements is found in the U. S. Army construction work during 1917-18. Here the contract was on what is known as the "cost-plus-a-sliding-scale-fee" with a maximum upset fee.

Overhead expenses and interest costs reduced the actual profit to most cantonment contractors to less than 1½ per cent. In this case the specified cost of the work included all payments of whatever nature with the exception of overhead costs of the contractor including financing expenses.

The union scale of wages prevailing in the locality of the work under consideration as of June 1917, was agreed upon by the Secretary of War and the President of the American Federation of Labor as the scale for the camp. Rules in reference to overtime, and for the regulation of hours of work, were agreed upon in advance between the constructing quartermaster and the contractor, in accordance with conditions prevailing in the district where the work was done.

The question of whether or not the Government got a fair return on its investment depended largely on the adequacy of the auditing and checking system which the constructing quartermaster carried out on the job.

There is no room for doubt as to the wisdom of the U. S. military establishment having acted wisely in adopting the cost plus form of contract for its emergency work. Speed was of vital importance. Abnormally high speed always means abnormally high cost. But in this war emergency abnormal construction costs were of no significance as compared with the saving in blood and general war cost which resulted from such construction speed.

In this connection it is well to recall that the government through priority arrangements had the benefits arising from the commandeering not only of materials and of labor but also of transportation. Such benefits do not attach to peace time work in any field.

General Considerations Regarding Contract Work

On contract work engineers should not be compelled to do the work of both the engineer and the contractor because contractors should be more capable than owners or their representatives to handle advantageously and economically the details of construction requirements. Contracts should therefore be drawn in such a manner as not to limit the work and responsibility of the contractor to the furnishing of labor and to the execution

of details under the absolute direction of the owner and his engineer. Responsibility for good construction and final excellency of the work should rest with the contractor.

To insure satisfactory results from cost plus lump sum agreements the contracts should provide for the reimbursement of the contractor for all amounts actually spent by him, such expenditures being limited in the case of materials to their normal market value and for labor to price schedules of local labor unions. The lump sum fee allowance should include the services of the works superintendent and hand tools and such small equipment as would obviously be required for the work. For plant equipment such as machine tools, excavators, cable ways, etc., a per diem rental under stipulated conditions should be fixed or bids should be received. To prevent disputes the plans and specifications should be as carefully prepared as for other types of contract.

Good examples of cost plus *lump sum* agreements are found in the U. S. Housing Bureau and other government contracts which provide for a rental price for plant equipment and a contractor's fee for services, on all of which bids were taken from a list of acceptable contractors.

The plant equipment fee covered the rental of all machinery, scrapers, scaffolding and tools, and all material which did not enter into permanent work. It did not include, however, lumber for temporary forms, concrete centering or the bracing and supporting of these forms or light staging or scaffolding on the exterior of structures.

The contractor from his fee was obliged to pay all costs of transporting, loading and unloading the plant equipment, and all upkeep and maintenance charges, fuel, oil, office overhead and general superintendency. A bonus was allowed the contractor, in addition to the lump sum fee which he bid, in the amount of one-fourth of any saving he was able to make as compared with his accepted estimated cost of the total work.

Under this agreement the contractor financed the entire construction work and was reimbursed by the owner for all such costs. A very strict system of inspection and accounting was maintained by the government.

Profit sharing methods have considerable merit over the straight cost plus forms in that they give the contractor some incentive to keep the cost of the work down. A method which has been used with considerable success in Canada is described by Mr. R. O. L. French. By its terms the contractor receives 20 per cent. of the estimated cost and rebates to the owner 10 per cent, of the actual cost.

Contract Adjusted to Varying Labor Prices

Mr. Morris R. Sherrerd, Chief Engineer of the North Jersey District Water Supply Commission, in a recent contract for the construction of the Wanaque Dam provided for an adjustment of certain labor costs after the year 1920, provided such costs are 10 per cent. above or below normal 1920 prices. This places the burden of changes in material costs on the contractor, but causes the owners to share with the contractor unusual changes in labor costs. The advantage of this type of contract as to labor over cost plus agreements lies in the fact that the contractor is compelled to exercise the same careful supervision and that there is the same necessity for economical construction methods as is required on lump sum and unit price agreements, but he is not obliged to shoulder all responsibility for unexpected price changes.

In the Wanaque Dam contract, labor is a controlling item, but on ordinary construction work, particularly on comparatively small jobs, and where the value of labor and material are more nearly equal, there would be less advantage in it. To be more generally applicable the adjustment in prices should if possible include material as well as labor, and furthermore the length of time between successive adjustments should also be made to conform to the size of the contract and to the probable duration of construction.

The adjustment of prices is more difficult in the case of materials than for labor, because of the greater number of materials and also because of the variety of materials which might satisfy any particular specification. On this account the furnishing of the principal materials to the general contractor through separate contracts made by the owner may be advantageous in that the risk would be more widely distributed and the adjustment of prices made somewhat more simple and definite.

At a time when transportation facilities are abnormally inadequate the assumption by the owner of the responsibility of furnishing materials cannot eliminate wholly the troubles arising from the enforced intermittent use of the contractor's laborers.

Summary and Conclusions

1. Pre-war construction contracts were for the most part, and rightly so, agreements on a lump sum or a unit price basis. Cost plus contracts were used only on certain large work done for private corporations or as a part of other types of agreements.

2. During the war the United States Government construction and much other work was done on a cost plus basis. Where proposals on a lump sum or unit price basis were obtained, the prices were intended to be sufficiently high to insure against loss due to constantly changing prices and the scarcity of labor and material.

3. Since the war, the procedure has been somewhat unsettled, with an effort to do away with some of the disadvantages of cost plus forms and to combine so far as possible the good qualities of both types of contracts.

4. The unit price contract under normal stable market and transportation conditions is the most satisfactory. The lump sum contract is principally advantageous in that the final cost is definitely known at the outset.

5. Cost plus contracts, with proper provision for accounting and supervision, may be satisfactory where conditions are not definitely known and in the case of private corporations where well qualified contractors may be selected to work under adequate supervision. Under war conditions cost plus contracts were necessary and even now have many advantages.

6. Construction work for private corporations may be successfully carried out with proper safeguards under any of the discussed forms of contract. For general construction work under municipal control the nearer a contract approaches the well-established lump sum or unit price contracts, if indeed any departure from such contracts is legal, the more satisfactory will be the results secured.

7. Until such time, however, as the material and labor markets are better stabilized, contracts should in fairness place the burden of uncertainty on the owner and not on the contractor. This may be done as follows:

(a) For much municipal work a form of contract may be adopted along the lines proposed by Mr. Sherrerd, and modified as suggested as to labor and material adjustments at proper intervals.

(b) For municipal or other work contracts may provide for the furnishing by the contractor of such labor and materials as are reasonably stable, with adjustment for changes in the labor market, and with materials of unstable price furnished by the owner through separate contracts.

The foreging paper by Mr. Fuller was presented before the annual convention of the American Water Works Association on June 24, 1920, at Montreal, Quebec.

EFFICIENT METHODS OF MAINTAINING GRAVEL AND BROKEN STONE ROADS

By G. C. Dillman, Maintenance Engineer, State Highway Department, Lansing, Mich.

Gravel Roads

The kind and extent of maintenance of gravel roads depends somewhat on traffic conditions and future development. The method of keeping up a gravel road in a community where the traffic is light may be very similar to that employed in maintaining a road that gets heavy traffic under the most trying conditions. So I would say that in general we may think a certain method best yet there is bound to be a varying degree of intensity to get proper results.

While the maintenance of a gravel road is comparatively simple, so far as methods and general knowledge of the materials is concerned, yet it is one of the improved types of road which is so commonly neglected. The old adage, "familiarity breeds contempt," surely can be applied here. Of course there is a limit to what traffic a gravel road can be subjected to and still be maintained economically, but when that limit has been reached our problem then becomes one of reconstruction or building a more permanent type.

The proper time to begin work on a gravel road is early in the spring just as the frost comes out of the ground. At this time the surface is somewhat loosened from the frost action and it is possible to move the old material with more ease than at any other time during the season. Some gravel is usually thrown out by traffic and this should be drawn in towards the center of the road to fill ruts and low places. All oversize stone projecting through should be removed before adding new material because they invariably work to the surface and make it rough.

When possible new material should be added during the early season as at this time it will bond much easier. An attempt should be made to replace each year as much gravel as is worn off. Do not put too much, however, at any one time. A light course will not interfere with traffic and a smooth uniform surface will be had by frequent dragging until the gravel is compacted.

Care should be taken in selecting the repair gravel as best results are obtained when it is of the same quality as that already in place. This will result in a more uniform surface which is very desirable.

Gravel that is used should not exceed 1 in. in size for heavy traffic roads. For roads having a light traffic the size may be increased such that all material will pass a 1½-in. circular opening. If it is impractical to screen the gravel as is generally the case in winter hauling the oversize stone may be spiked out and removed from the road.

All depressions and shallow ruts should be kept filled. This is most economically done by shoveling the gravel from the patrolman's truck, wagon or wheelbarrow into the depressions. Take advantage of rains as the depressions are then most readily observed and the water will aid the new gravel in bonding onto the old surface and in its compacting under traffic.

New material should be available along the roadside when the road is patrolled. Stocking space should be provided for if such was not done when the road was constructed. Whenever possible make use of convenient places outside the ditch lines. In this way the piles will not interfere with traffic and will not obstruct the drainage system. Take advantage of rains and keep the surface smooth and uniform by systematic dragging. If this is not done regularly or if the surface has become hard it may be necessary to use the heavier road grader or planer. However, for efficient work the gravel road must be dragged regularly. Whether that be done once each week or every day will depend on traffic demands. In any case do not disturb the old gravel bed any more than is necessary to maintain the proper shape and crown.

In some sections of the state and in all, at times, trains are not available for this work. A two or three-ton truck or a light tractor will pull one or two road planers, a light grader or a three-way drag and do satisfactory work. More motive power must be used but to get as good results as with teams, operators should be frequently cautioned to use more judgment and less speed.

Calcium Chloride Treatment

Excellent results have been had from the use of calcium chloride as a dust preventive on gravel roads. The use of this material has been somewhat limited due to the fact that it has been hard to get until recently. Specifications have just been prepared for the Michigan State Highway Department from which I quote:

"The material shall be in the form of loose dry lumps or flakes free from dust and fine enough to feed readily through the common forms of spreaders used in road work. The calcium chloride shall be delivered in tight steel drums about 21 ins. in diameter and 32 to 34 ins. high. The name of the manufacturer, the lot number, and the percentage of calcium chloride guaranteed by the manufacturers shall be plainly marked on the drum."

To obtain the best results the road surface to be treated should be in good shape at the time the material is applied. That is, the road should have been dragged thoroughly, having the surface smooth and of proper cross section. The material may be spread with shovels but it is not advisable if a considerable mileage is to be covered. A regular distributor or drill should be used as it not only speeds up the work but a uniform distribution is insured. The latter is very important.

For the first application about 1 to 1½ lbs. of calcium chloride per surface yard should be used. This will ordinarily be followed later in the season by a second treatment from ½ to 1 lb. per surface yard. The number of treatments and amount used during the season will depend upon the nature of the gravel and the kind and intensity of traffic. For the best results apply the material after a rain as the chloride will readily dissolve and better penetration can be had.

Workmen should be provided with rubber boots and gloves other than leather when handling this material. The chloride will practically destroy leather and the hands will become sore when in contact with it.

A proper application of calcium chloride will render a gravel road practically dustless and it acts as a binder. Another good result from the use of this material is that the treated surface is more easily maintained by dragging.

The cost of calcium chloride treatment of gravel roads is reasonable. This varies from 2½ to 3 cts. per square yard of surface treated.

Broken Stone Roads

Until the automobile became such a factor as a means of transportation the waterbound macadam road proved both economical and fairly satisfactory. The present automobile and heavy truck traffic combined with the steel tire vehicular traffic has proved this type of construction inadequate even though the construction has been first class. Notwithstanding the shortcomings of this type of road when put to such use many miles will continue to be built each year and here lies the source of one of our big maintenance problems.

Untreated waterbound macadam roads are generally subject to more or less rutting and pitting. By holding the crown to a minimum and having the metal of good width this tracking and rutting can be prevented somewhat. Yet the most effective thing is to keep traffic distributed.

The ordinary method of repairing a hole or depression in waterbound macadam is to make a waterbound patch. Whenever the foundation fails it is best to pick loose and shovel out the old base course and go down far enough to secure a solid foundation. New stone will then be added and compacted by hand tamping or better by rolling, after which screenings are added and waterbound in the same way a new road of this type is built. In case large areas are to be repaired it will prove more economical to do two course work. To get the best results use as large stone as is practical, thoroughly key by tamping or rolling, apply screenings evenly and not more than are needed and work into a good grout. Advantage should be taken of rains when making such repairs as this will aid in bonding the newly made patch.

Patching waterbound macadam with a mixture of a bituminous material and stone is coming into quite common favor. It is a rapid way of making such repairs and I believe economical but I would advise the bituminous patch only in case the macadam is to be surface treated. An important thing and which is so often neglected is to cut the sides of the hole vertically and thoroughly sweep out all foreign matter. Then paint the hole with the bituminous material being used in the mix, deposit the mix and tamp or roll. The larger the stone used the better, but the size will depend on the depth of the hole. A precaution should be taken not to use an excess amount of the bituminous material else the patch will not "set up" nor stay in place.

A great many of the old broken stone roads are badly worn and pitted and when in that condition should not be surface treated. In case there is a good thickness of compacted metal still remaining an effectual way of repairing this is to fill the holes and ruts with new stone, scarify lightly, shape the stone to a uniform cross section and roll thoroughly. Should the old metal be worn thin the problem is then one of reconstruction.

Gravel, preferably containing a small per cent. of clay fills, not exceeding ¾ in. in size is sometimes used as a top dressing for waterbound macadam. A badly worn metal can be greatly improved by its use. It binds quite readily and the surface is floated the same as a gravel road.

In my opinion the only efficient maintenance that can be put on waterbound macadam roads is a bituminous surface treatment. Such an application protects the stone from external wear, water-proofs the surface and renders it practically dustless.

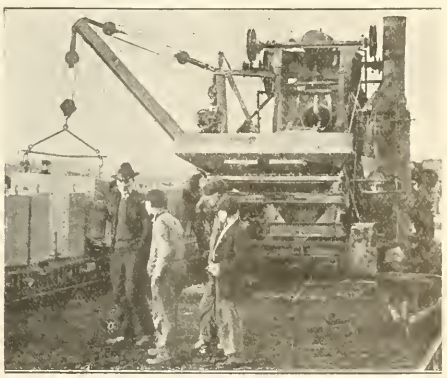
Acknowledgment

The foregoing paper by Mr. Dillman was read at the recent Short Course on Highway Engineering at the University of Michigan.

A NOVEL BATCH BOX DERRICK

Road contractors with contracts for several miles of road work are giving more serious consideration to industrial car systems this year than ever before because of the numerous labor-saving features presented.

An item of importance to be considered, in connection with the industrial car system, is the adaptability of the paving mixer to a system of this sort. The 1920 model of the Smith Simplex paving mixer is especially adaptable to an industrial car system because of, among other features, its arrangement for raising the batch boxes. The derrick is not operated as a separate unit and there-



VIEW SHOWING OPERATION OF BATCH BOX DERRICK.

fore does not require any additional levers for the paver operator to manipulate.

The system operates simply as follows: As the skip is raised the cable on the derrick lowers and the derrick is swung over to a position where cable hooks onto one of the waiting batch boxes. After the contents of the skip have been discharged into the drum of the mixer the operator merely lowers the skip and the batch box automatically raises. The derrick is then swung over to a point above the skip and by the time the skip strikes the ground the batch box is directly over it. No lost motion, no waiting.

ASPHALTIC ROADS IN ARKANSAS

The state of Arkansas has undertaken a road program which will give a total of 9,000 miles of improved highways in this state when the work has been completed. Three hundred miles of this project have already been constructed; 4,300 miles are now in the process of building, and 4,400 miles are in the preliminary stages of organization. The program will include every type of street and highway construction, from the cheapest graded dirt road to a permanent asphaltic concrete pavement.

Of the entire 9,000 miles, 1,089 miles will be of asphaltic construction. This means that there will be greater mileage of asphalt roads than of any other type with the exception of gravel.

The greater part of the asphaltic construction will be asphaltic concrete on stone or concrete base. This type of pavement has for the last ten years demonstrated its practicability on county highways and on city streets. It is economical in first cost, is easily and cheaply maintained, and presents a very pleasing surface to the eye.

Of the work under contract and construction in Arkansas the following summary shows the mileage of the various types of surfacing:

One course Portland cement concrete	192 miles
Asphaltic concrete on stone or concrete base	629 miles
Penetration macadam	460 miles
Water bound macadam	560 miles
Gravel road	2,209 miles
Earth	250 miles

CONTRACTS AWARDED

Ariz., Flagstaff—Warren Brothers Bitulithic Co., Phoenix, awarded contract for paving the Old Trails Hwy. thru Flagstaff, at about $74,000. This includes cost of bridge work over the River de Flag.

Ark., Mena—Early & Jones, Sheridan, Ark., awarded contract for 23 miles Mena-Big Fork rd.; Maxwell Constr. Co., Columbus, Kans. 16 mi. Mena-Okla. Rd. total cost $379,942.

Ark., Paragould—E. J. Scott, Rialto Bldg., St. Louis, Mo., awarded contract for bldg. 22 miles of road for Hazelwood Rd. Impvt. Dist. No. 2. Approx. cost $125,000.

Ark., Walnut Ridge—C. L. Hager, Walnut Ridge, awarded contr. for grading, culverts and bridg. Lawrence Co. Rd. Impvt. Dist. No. 4, 5.85 mi., at $120,000.

Ala., Anniston—J. F. Morgan Paving Co., Birmingham, awarded contr. to pave Noble St.; asph. conc., at $96,705.

Cal., San Diego—Jno. Engebretsen, McNeece Bldg., San Diego, awarded contr. for paving Tide St. with 5-in. conc. base and asphaltum wearing surf., at $76,347.

Cal., San Luis Obispo—Ira Hodson, 227 W. Anapamu St., Santa Barbara, awarded contract for paving Traffic Way in Atascadero. with 4-in. concrete; county to furnish cement, at $11,904; Hunt-Waugh Constr. Co., 1847 West 43rd Street, Los Angeles, awarded contract for paving with 5-in. concrete the San Luis Obispo-Cambria Road, Route 3, Sect. A, County Hwy. about 11 miles; county to furnish cement, at $171,625.

Cal., Santa Monica—J. D. Kneen Contracting Co., Dudley Blk., Santa Monica, awarded contract for paving San Vicente Blvd. betw. Seventh and 26th Sts. with bitulithic, at $112,692.

Conn., Shelton—Conn. Natl. Pavements, Inc., New Haven, awarded contract for paving Home Ave., asph., at about $86,000.

Cal., Venice—Braun, Bryant & Austin, Inc., Santa Monica, awarded contract for paving Morningside, Appleton, Preston, Alexandria and Vienna Way, Glyndon and Penmar Aves. and Nowita Pl. at 2.5c sq. ft. for grading, 22c sq. ft. for oil macadam paving, 18.7c sq. ft. for cement walk and 58c ft. for cement curb; also contr. for paving Sunset Ave. at 5c sq. ft. for grading, 23.5c sq. ft. for 5-in. conc. paving, 18¼c sq. ft. for cement walk, 65c for conc. curb and $5.15 lin. ft. for retaining curbs.

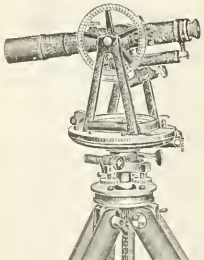
Cal., Visalia—Federal Constr. Co., San Francisco, award. contr. for paving abt. 2½ miles city streets, at $224,533.

Del., Dover—State Hwy. Dept. let contr. for bldg. 3.82 mi. Rd. Contr. 29, Felton-Dover, Kent Co.; also 3.4 mi. Rd. Contr. C. S. 6, Coverdale Cross Rds. Jacobs Sch. Sussex Co., to Kent Constr. Co., Chestertown, Md., at $181,293 and $162,996, respectively; 1.09 mi. Church and Williams Sts. and Roxanna Rd. Sussex Co. involving 1,620 cu. yds. conc., etc., to Empire Constr. Co., Phila., at $36,620; 5.27 mi. Rd. Contr. 27, Armstrongs-Comer-Pine Tree, New Castle Co., 10,670 cu. yds. conc., to Keystone State Constr. Co., Commercial Trust Bldg., Phila., at $332,036.

Fla., St. Augustine—Ackerman & Maule, Titusville, awarded contr. for bldg. 111 miles hard surfaced roads, at $1,196,908.

Ga., Savannah—Dixon Contr. Co., Savannah, awarded contr. to pave 13,000 sq. yds. W. Broad St.—Gwinnett to 31st St.

Kolesch Surveying Instruments



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EDITORIALS

ENGINEER AND PROMOTER

In these columns last month two prominent engineers were quoted in their endorsement of a promoter's candidacy for the United States Senate. They referred to him as a promoter of the type to which engineers are deeply indebted. They said: "It is such men who have made possible the practice, promotion and development of the profession to which we belong." The editor expressed the opinion that this view of the promoter comes much closer to the exact truth than statements frequently made by engineers on this subject.

The engineer will lose nothing to which he has just claim in acknowledging his debt to the promoter of an enterprise ultimately requiring the exercise of engineering talent. But engineers stand to lose much of the regard of other men when they set the promoter at naught and claim all the credit for themselves in the consummation of a work which adds to the public wealth and happiness. At times the engineer has, perhaps, rather thoughtlessly regarded himself as the chief builder of a railroad, to take an illustration familiar to all but outside the field of this magazine, failing to recognize that he has been but one of the various classes of men who have cooperated in the achievement. This narrow view is not well calculated to increase the popularity of the engineer or to enhance the regard in which he is held by men of affairs.

Of course there are promoters and promoters. The Wallingford type is known in fact as well as in fiction. Opportunities to abuse the functions of the promoter exist but the seizure of such opportunities should not reflect discredit on honest endeavor. Legitimate promotion we must have in order to accomplish anything worth while calling for engineering services. It is with a proper regard by the engineer for these legitimate functions that we are concerned in this discussion.

Just as there are different types of promoters so, also, are there different types of promotion. Sometimes promotion is an end in itself and sometimes it is a means to an end. An example of the latter class of promotion, familiar to all, is that done in connection with the sale of equipment or the materials of construction. In this case the seller engages in the promotion of projects on the construction of which his equipment or construction materials may later be utilized. This is a very important class of promotional work which exerts a strong influence on the engineer, both with respect to the performance of his services and in the creation of his opportunities to serve. Stated more plainly, the promotional activities of equipment and material men not only must be reckoned with at times in the performance of the engineer's work, but the engineering job itself may, and frequently does, depend directly on the success or failure of these promotional activities of the so-called "supply men." Isn't it well to recognize these facts?

Frequently it has seemed to us that engineers are disposed to take a rather ungenerous view of the salesman's efforts to create a demand for his goods. There is such an over-supply of indolence and lethargy in the world that without vigorous efforts few things can be sold in worth-while volume. The entire construction industry is indebted to the honest promotional and sales efforts of the material men. No matter how legitimate the project it must be sold to the public and the selling is frequently done by commercial interests as one step in the sale of equipment and supplies. So long as these activities are honestly and fairly conducted no one should take exception to them, last of all the engineer who finally is called upon to perform his function on a project which has been sold to the public with or without his assistance.

We are moved to make these frank observations in the interest of straight thinking and in giving credit where it is due. We object to narrowness as the greatest obstacle to the normal development of the profession. Let us not be too harsh in our criticisms of the manufacturer's salesman; his job is a hard one and he needs cooperation as well as criticism.

As an example of the sort of short-sighted criticism to which we have made reference the case may well be cited of a state highway engineer who said: Many persons, especially those interested in the manufacture and sale of motor vehicles have become dissatisfied with the results secured under the Federal Aid Highway Act." We confess we can see nothing in this statement but a gratuitous "slam" at the agency which has done more than any other for good roads in this country. That motor interests have been, are, and will continue interested in fostering the good roads movement everybody knows. There has been no secrecy on this point. Of course, motor interests are anxious to promote the construction of good roads, and why not? There are obstacles in plenty, never fear, and there is no danger of over-promotion that we can detect. It is indeed fortunate for the country that there has been built up a vigorous young industry which possesses the requisite energy, money and brains to work successfully for a national system of dependable highways. We surmise that the labors of this group are largely responsible for the fact that we have 48 state highway departments and 48 state highway engineers. Even in those states which had highway departments before motor interests and motorists took up the good roads crusade, much favorable sentiment has been built up, directly and indirectly, to support those departments as a result of the educational work carried on by "those interested in the manufacture and sale of motor vehicles," aided and abetted by those

interested in the use of such vehicles. We have added a reference to the user of motor vehicles as he is on friendly terms with the "automobile people" and is often seen in their company. In fact, it is suspected that he buys and operates motor vehicles only because he finds it advantageous or quite agreeable to do so. We do not see any possibility for public service, therefore, in an insinuation made by a public servant against an agency which is serving the public so well that it profits from doing so. Perhaps it is well to add that these remarks are intended to be good natured and constructive. The state highway engineer quoted happens to be one who commands our admiration and respect and it is because of this that we regret his rather ungenerous reference to an agency which has extended much indirect assistance to all honest, sincere workers in the highway field.

That promotional work, whether carried on as a means to an end or as an end in itself, is neither always honest nor wise we are perfectly well aware. However deplorable this fact may be, let us remember that such activities are quite as likely to be inspired by high motives as any other. Where a real service is rendered let us not hesitate to acclaim it, whatever be the garb or the vehicle of the servant.

Many who appreciate the attainment and capacities of the engineer are looking to him to do more and more of the promotional work himself. Engineers, therefore, who are dissatisfied with the promotional work which comes under their observation, have a perfect right to assert themselves and do their own promoting.

In a recent editorial The Lexington, (Ky.) Leader, in the course of a discussion of the non-capitalistic captain of industry (the engineer) said: "It is now a large practice for engineers of ability to seek out independently opportunities for the investment of capital or for the utilization of natural resources. Herbert Hoover is one of the successful examples of this latter class who are sure to grow in numbers and influence every year. The engineer is becoming so important, as a matter of fact, that the day may not be long distant when he will take first place in industry and progress, the place occupied for centuries by the capitalist."

We trust engineers will give thought to these matters and that they will view with a generous eye the works of which they are among the chief beneficiaries. Where they feel that they can improve upon the promotional work being done by others, they are at complete liberty to make the attempt, assured of a rich reward if they succeed.

PRIDE IN A DAY'S WORK

In early life it was our privilege to sit at the feet of men who took deep pride in doing a big day's work. They gloried in their strength and welcomed the opportunity presented each day for their maximum production. Such were the makers of America. Men of that breed conquered the wilderness and the great barren spaces and made them productive and useful. America is still sound at heart because of our nearness to these men. Our literature abounds in tributes to them. Longfellow's Village Blacksmith appeals strongly to all for it recognizes the nobility of labor and renders homage to a true man.

Organized labor has derived its strength largely from public sentiment based on the older conceptions of labor and an honest day's work. The overwhelming majority of Americans have engaged in hard manual labor, day after day, over a long period of years, or are but a generation removed from it. Most of us have looked with sympathetic eyes on the efforts of laboring men to improve their living and working conditions, remembering old times and the old, old injustices to the toiler. But always we have expected that labor would continue to be worthy of its hire.

Latterly a serious question has arisen as to whether or not labor can stand its prosperity, so recently acquired and so long sought. Pride in the day's production has been superseded by hot demands for higher and still higher wages in exchange for lower and still lower production. Many feel that labor has abused its newfound strength. The laborer with his incessant strikes and his cold, calculating time-killing is rapidly losing the sympathy of the great middle class, the white-collared group that stands between labor and capital and would preserve justice and order in industry just as the old marines stood between the forecastle and the quarterdeck to put down mutinies arising in one end of the boat and to protect the ordinary seaman against the heartless autocrat who held forth in the other.

Unless organized labor abandons its false idea of limiting production to increase prosperity it will suffer an irreparable loss. Already it has alienated the sympathies of a multitude of its former well-wishers. The entire labor movement is doomed to early and complete disaster unless laboring men again work hard. They must produce, thus earning more, or forfeit all claim to public sympathy in their efforts to get higher or even their present wages.

We believe that practically all our people believe in a square deal. They want to see the laboring classes properly compensated and adequately protected against ruthless exploitation. But the public will sternly insist that labor do its part. Labor must return to the old way of working or lose its present high wages. The individual laborer is quite capable of differentiating between what is right and what is wrong. He must do what he knows that by every standard of right he should do: he must work hard.

DESIGN OF THE MIAMI, FLORIDA, CAUSEWAY ACROSS BISCAYNE BAY

By B. H. Klyce, of Klyce & Kackley, Civil and Consulting Engineers, 721 Fourth and First National Bank Bldg., Nashville, Tenn.

The Miami Causeway is being completed across Biscayne Bay on the southeast coast of Florida to connect the City of Miami with the City of Miami Beach.

Both Miami and Miami Beach are well known winter resorts, and Miami is of some commercial importance, which will be much enhanced in the next few years as the Everglades are drained and opened for settlement.

Miami Beach is located on a peninsula but heretofore the only means of communication with the main land has been a wooden bridge nearly three miles long spanning the bay and connecting the two cities; this bridge was wholly inadequate and was decaying rapidly; it became necessary to replace it with something more permanent.

Biscayne Bay is a shallow body of water having an average depth of water at this point of about 5 ft. except along the eastern side where there is a dredged channel 2,000 ft. wide with a depth of water of about 15 ft. Five to 15 ft. of sand and mud overlie the soft rock bottom peculiar to this region. This rock is quite porous, has many "pot-holes" in it and is so soft that it may often be excavated with an hydraulic dredge without the use of explosives; in general, however, it is found cheaper to use explosives; large boulders however are rarely dislodged, most of the debris being capable of being handled by a 20 in. hydraulic dredge.

Elements of the Causeway

The normal range of tide in the bay is about 18 ins., and since there are no streams of any importance emptying into the bay above the causeway, permission was secured from the War Department to make a solid fill 13,000 ft. long flanked at either end by an opening 2,000 it. long to be spanned with concrete viaducts; in each one of these viaducts is placed a bascule bridge with 60 ft. clear opening.

The embankment is located along the north side of the ship channel which crosses the bay; it is parallel to this channel and has its south wall about 82 ft. distant from the north side of it. The excavated material from the ship channel had been deposited along the north side of it largely by hydraulic dredge and is in a very compact condition; it is composed of a mixture of sand and rock with some mud; it is on this spoil bank that the embankment for the causeway is constructed.

In designing the embankment portion it was considered important that such a structure would be built that it could resist the tropical hurricanes which occasionally sweep this region. It is not anticipated there can be much damage from direct wave action since the bay is quite shallow.

Three Types of Construction Considered

Three types of construction were considered: (1) An embankment with sloping sides protected by riprap, (2) an embankment with sloping sides protected by marl, and (3) an embankment with vertical sides. The first design had to be rejected since the only stone locally available for riprap is soft, light, friable and furthermore cannot readily be secured in large masses. The second design with the slopes protected by pure marine marl laid on flat slopes of about 6 to 1, such as used quite successfully by the F. E. C. Ry. on some of their well known over-the-sea railroad construction, was not feasible on account of expense, there being no known beds of pure marine marl locally available. In considering the third type it was not possible to consider anything other than cresoted lumber for the walls on account of the limited appropriation.

The embankment as designed is 105 ft. wide and is composed of two parallel walls of cresoted wooden sheet piling and waling tied together with wrought iron tie rods and filled with sand and rock. The piling are driven nearly to rock. The ends of the tie rods where exposed to the weather are protected by a coat of hot pitch. The entire surface is now being paved with the native broken stone to a thickness of 12 ins. applied in two courses. This stone has a peculiarly high cementing power and makes a pavement practically impervious to water.

A street car line has been built and a 40 ft. oiled macadam highway is being constructed now with provision made for a steam railroad and a concrete sidewalk to be constructed in the future.

The Viaducts

The viaducts are of reinforced concrete construction and are composed of a series of spans each 30 ft. center to center of piers. Expansion joints are placed 120 ft. apart. The viaducts provide for a roadway 20 ft. wide, a sidewalk 5 ft. wide on one side, and one electric railway track on the opposite side outside of the roadway. The portion occupied by the electric railway track consists of open track construction carried on steel L-beams of 30 ft. span. The roadway is paved with Kentucky rock asphalt, the sidewalk is of concrete and there is a concrete handrail on the sidewalk side only. The load-

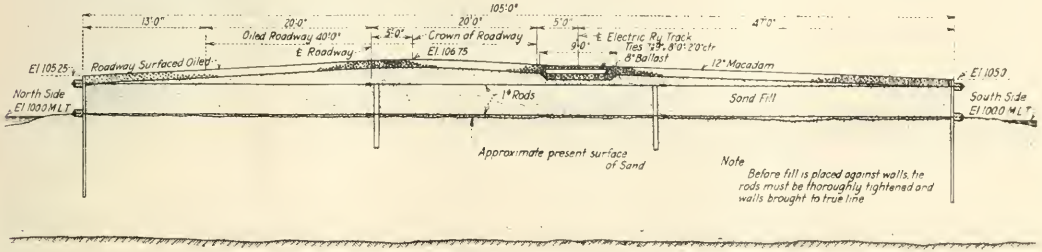


FIG. 1. TYPICAL CROSS SECTION OF EMBANKMENT, SHOWING TIMBER BULKHEAD CONSTRUCTION, THE MIAMI CAUSEWAY, ACROSS BISCAYNE BAY, MIAMI, FLORIDA.

ing provided for is two 40-ton cars with impact on each electric railway track, while on any part of the roadway a 9-ton motor truck with impact or a uniform load of 100 lbs. per sq. ft. without impact is used.

Construction Features

The principal point of interest in the construction of this part of the work is the method used for the construction of the pier shafts. Soundings were taken where each shaft was to be placed and its exact length to the underside of the cross girder determined; then the shafts were all cast at a yard conveniently located where the work could be most carefully inspected for the placing of the reinforcement and of the concrete; it should be noted that the vertical rods for connecting of pier shafts to cross girders and also to basis were left projecting;

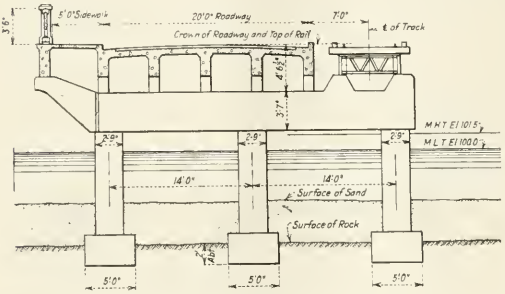


FIG. 2. CROSS SECTION OF THE MIAMI (FLA.) CAUSEWAY.

they were then allowed to cure at least three weeks before being moved. They were then picked up by a derrick barge which utilized the projecting reinforcing rods to lift them by and loaded them on barges, which were then towed to the site of the work.

In the meantime the excavation for the pier bases had been completed and the caissons driven. The derrick barge now lifted one of the pier shafts and suspended it in its proper caisson and exactly in position leaving it a little high; wooden blocking was now placed across the caisson resting on the steel sheet piling; to each of the reinforcing rods in the four corners of the pier shafts had previously been attached a threaded rod with hexagon nut, by means of which the load of the pier shaft was taken from the derrick and transferred to the blocking; also it was now possible by lowering on one or more corners to secure exact verticality of the pier shaft. Then the concrete for the pier bases was deposited by tremie, care being taken to see that the concrete was brought high enough to insure that the laitance which averaged about 6 ins. thick would all be above the bottom of the pier shaft. It will also be noted that the bottom of each pier shaft was shaped as a blunt wedge to prevent likelihood of air being pocketed underneath in the placing of the concrete for the base. One complete pier shaft and base which had been damaged were lifted out of the water and the base cut away to determine whether solid contact over the whole area of the base of the pier shaft was being secured; this was found to be the case.

By this method of construction it was possible to secure a "dry-land" viaduct. It should also be noted that since these piers were reinforced and to be subjected to the action of salt water the utmost care was taken to secure a very dense and impervious concrete by importing a very superior grade of sand and by general care in the mixing and placing of the concrete.

The bascule bridges are of the Scherzer Rolling Lift Bridge type.

Contracts were let in the latter part of 1916 for the construction of all this work except the bascule bridges to the Bowers Southern Dredging Company of Galveston; the bascule bridges were constructed by George O. Reed Co. of Michigan City, Ind. All of the work is now completed except a portion of the roadway paving. At the contract prices the embankment portion of the causeway will cost $23 per lineal ft. while the viaduct portion will cost $70 per lineal ft. exclusive of engineering, legal or other administration expense. The total cost of the work is $650.000. At present prices for materials and labor these costs would be doubled at least.

Klyce and Kackley of Nashville, Tenn., and Miami, Fla. are the engineers with Wm. E. Wilbur as resident engineer.

HOW CITIES OF NEW YORK STATE DEFEATED EFFORTS OF STREET RAILWAY COMPANIES TO ESCAPE COST OF CAR TRACK PAVING.

By William P. Capes, Director of State Bureau of Municipal Information of the New York State Conference of Mayors and Other City Officials, 25 Washington Ave., Albany, N. Y.

(Editor's Note:—A movement, nation-wide in its scope, has been started by the street railway companies to repeal or modify laws and franchises requiring street railway companies to construct and maintain the pavement between, and a certain distance on either side of their tracks. How the effort was defeated in New York State by the cities will be of interest to the cities of other states. The present article by Mr. Capes gives a summary of the arguments which the cities used before the State Legislature in opposition to the bill presented at the latest session.)

As a result of a nation-wide agitation by street railway companies, public service commissions and other similar regulatory bodies in a number of states have, within the last year or two, recommended that state laws and local franchises, requiring traction companies to construct and maintain pavements between and a certain distance on either side of their tracks, should be changed, so as to relieve the corporation of this expense. Among the state bodies making such a recommendation was the Public Service Commission for the Second District of New York. In its last annual report to the Legislature it said:

Recommendation Made by Public Service Commission for the Second District of New York

"The attention of the Legislature is directed to those provisions of section 178 of the Railroad Law which require street surface railroads to have and to keep in permanent repair that portion of any street, avenue or public

place between its tracks, the rails of its tracks and 2 ft. in width outside of its tracks. In nearly all cities it has been necessary to increase the rates of fare on street railroads, so that the 5-cent fare formerly in common use has been largely superseded by higher rates. The commission is of the opinion that it is highly desirable to return as soon as possible to the 5-ct. fare. Increased fares tend to decrease the volume of travel, and it seems evident that in such case the passengers who discontinue the use of street car facilities must in large part comprise that element of the community which most feels the deprivation. The requirement of street paving and repair in the statute referred to constitutes a very heavy financial burden on the urban line, which, of course, must be recouped out of earnings. We beg to point out that the conditions which gave rise to this statutory requirement have, at least in the larger communities, for the most part passed away. At the time of the imposition of this burden there was little or no construction of the present so-called permanent type of either track, track support, or pavement. With the cobble or sand stone pavements of that day, laid on sand, there was a strong tendency for those in charge of horses and vehicles to make use of the track as the smoothest part of the roadway. The result was the rapid disintregration of that part of the pavement contiguous to the rails, for which naturally the railroad company was held responsible. It will be recalled that at that period street cars were universally drawn by horses, and the use of the pavements between the tracks by such horses was very great, and contributed in large degree to the wearing out of the pavements. With the present heavy construction of both railroad and pavement, supported by concrete, and the substitution of motors for horse-drawn vehicles, these conditions have largely ceased to exist. We therefore believe that the Legislature could with justice require the modification of this requirement."

This summarizes the arguments that have been presented by the traction corporations in support of their contentions that they should be relieved of this item of expense.

Following this report the New York State Street Railway Association drafted and introduced into the Legislature a bill providing that traction companies be required to construct and maintain the pavement for only 6 ins. on either side of their rails in streets occupied by street railroad tracks. The law, which the association proposed to amend, requires the companies to construct and maintain the pavement between and for 2 ft. on either side of their tracks.

Cities Opposed Proposed Amendment

Through the New York State Conference of Mayors and other city officials, the 59 cities in the state opposed the proposed amendment. At the request of the chairman of the Senate Committee on Public Service, to which the bill had been referred, each city through its mayor and city engineer, filed a brief giving the reasons for its opposition.

The committee also received a report from the New York State Bureau of Municipal Information summarizing the data it had received from 166 American cities of 30,000 or more population. The report showed that of these cities 60 required the street railway companies to pay for the construction, reconstruction and maintenance of pavement (original, repavement, temporary and permanent) between and for 2 ft. on either side of their tracks. In 15 other cities the companies are responsible for the pavement between and 18 ins. on either side of their tracks, and in 11 others for 12 ins. on either side of their tracks. The plans vary in the remaining cities, but in all, except one, the companies are held responsible for the pavement of at least that part of the street occupied by their tracks.

The arguments presented by the cities in their briefs were so numerous and sound and so completely refuted the statements by the Public Service Commission that the bill was never reported by the Senate Committee.

As an aid to the cities in other states where efforts may be made to transfer the burden of paving expense from the traction corporations to the cities or abutting property owners, the New York State Bureau of Municipal Information has prepared the following summary of the arguments presented to the Legislature in the briefs submitted by the New York State cities:

Summary of Arguments Presented by Cities

1. The standard type of railroad construction in streets consists of laying wooden ties every 24 ins. apart on its sub-grade. Its ties are 6 ins. in width, 8 ins. in breadth and 8 ft. in length. On the ties are placed rails which are 4 ft., 8½ ins apart. These rails are held together every 16½ ft. of track with splice bars bolted to the rails, and over-lapping the splice bar is a bonding wire transmitting current to the rails.

2. The ties project 20 ins. outside of the rail and the bonding and splicing bar more than 6 ins. in many cases. In a street where double tracks are maintained, the space between the double tracks, usually called the "dummy track," is 56 ins., and with the tie spacing and tie extension as mentioned above, 40 ins. of this space is occupied by railway ties.

3. Heavy urban cars, and not the ordinary travel, are responsible for constant repair to pavements.

4. The weight of the modern electric car is from six to ten times the weight of the horse car formerly used. This weight produces a correspondingly increased vibration. As the wheels of the cars become flattened or otherwise defective, the vibration is tremendously increased. Vibration necessarily tends to disintregrate the material of which the pavement is constructed, and the greater the vibration the greater will be the disintregration. In addition, the railroad companies insist on running cars over tracks while the pavement is under construction, so that a complete bonding of the materials is seldom obtained. This causes a weak point in the pavement, not only along the rails but for the entire length of the ties (usually 8 ft. 6 ins.) In cities where the combined load of car and passengers is approximately 25 tons, it is self evident what happens to that portion of the pavement over the ties and ballast of the railroad company. The injury to the pavement from vibration is infinitely more destructive than any surface wear that could be produced by the travel of horses.

5. The old cobble stone and sandstone pavements used when horse cars were operated, were porous and the penetration of water into the sub-grade was unimportant. The modern hard surface pavement is of rigid construction, and requires for its preservation that the surface

be impervious to water. No pavement can be laid as securely with rails spaced at intervals at the center of the street with the same length of life as on a street which is free from rails. The contour of the street must be altered to provide for drainage along and adjacent to the rails, and the inability of any roadbed construction to withstand the seepage of water into it by creeping along the rails is well known. Water is the enemy of pavement, and the rails provide a means for the water to enter underneath the pavement, undermining it and causing it to heave or rot depending upon the nature of the paving material. The same degree of drainage cannot be provided on streets on which car tracks are operated as can be afforded on streets which have no car tracks. The rail affords the first opportunity for the water to enter the sub-grade. It forms the first point of weakness in the pavement. It is, therefore, the point at which the pavement shows first signs of decay. On Castle street, in the city of Geneva, upheavals from this cause have occurred during the present spring between the tracks for a distance of 15 ft. outside of them. The weight of traffic over the pavement in this upheaved condition results in a most destructive collapse or breaking up of the pavement.

6. It is impossible to maintain any modern satisfactory pavement adjacent to any car track construction unless such track construction is made right. The incentive to make such rigid construction now rests with the traction company to lessen the cost of pavement maintenance. With such incentive for the more expensive track construction removed, the company would naturally resort to a cheaper track construction, resulting in an increased cost of pavement maintenance, or would make such pavement most difficult if not impossible. The enforcement of pavement maintenance under the present law works practically to compel proper track construction as such provision, when in force, makes economical the proper track construction and maintenance. No relief from present obligations can be reasonably considered except in conjunction with thorough control of track construction and maintenance by the municipalities without soon creating an impossible condition of street pavement maintenance.

7. In case the company is to construct a track in a street already paved, it becomes necessary to tear up at least 9 ft. of pavement in order to lay the tracks. This pavement has already been paid for once, and it may be relaid after the tracks have been placed in such a way that it is apparently on the surface, as good as new, but there is a longitudinal crack in the base which eventually works toward the surface under the stress of constant vibration. This in a short time would mean constant repair.

8. In the case of replacing of ties, etc. by the railroad company, it is necessary to take up and replace a strip of pavement approximately 9 ft. wide. This is a charge which in all fairness should be paid by the railroad company. Long before the expiration of the life of the roadbed the railway company is compelled to disturb the pavements to shim joints, renew bonds, replace broken rails and retighten joints, and in performing this service it is necessary to disturb 20 ins. of pavement in order to make working room for men and their tools. It is found necessary to renew ties, even though they be bedded in concrete, before the pavement has served its life.

9. The constant tearing up of the pavement to repair car tracks is very detrimental to the condition of a street. A pavement which has been torn up cannot be restored to as good condition as before, consequently the location of railway tracks in a street necessarily tends to destroy the life of the whole pavement.

10. General street railroad engineering has established the fact that repairs to paving in the railroad area consume 17 to 20 per cent. of the total cost of maintenance of way, so a reduction of seven-ninths of this obligation would not help the railroad company more than the additional cent charged in a 6 ct. fare.

11. The life of the roadbed of a railroad company is about twelve years and the life of a durably constructed pavement is over twenty years.

12. It is a well known fact among engineers that no matter how well a pavement is constructed, it will heave along the rail line and does not settle back in the spring as it should. Each year increases the degree of this trouble. This cannot be attributed to vehicular traffic for in these days the majority of vehicles are motor driven, which usually means rubber tires, and it is the practice of most good drivers to keep as far from the rails as possible, if for no other reason than the protection of tires. It is also well known that street railroad companies use quantities of salt around switches in the winter time and this has a very serious effect on pavements.

13. The life of a pavement on any street in which street cars are located is reduced 50 per cent. As an illustration of this fact refer to Genesee street in Albany. There are no cracks from Castle street to Lewis street, and the pavement on this part of the street is in excellent condition, while the pavement on the rest of the street, in which tracks are located, is now in such condition that immediate repavement is necessary although both parts of the street were paved at the same time and with the same kind of pavement.

14. Defective rails cannot be properly removed and replaced in a 1 ft. area, particularly on curves.

15. Cities should not be required to pay for the cost of greater excavation and heavier construction required under tracks, which are necessarily purely for the support of a company's cars.

16. The presence of street railway tracks in a street necessitates a special and more expensive construction of pavement. It is necessary to make the concrete foundation 8 ins. to 10 ins. in depth between the tracks and at the side of the tracks, instead of 5 ins. in depth, as in other parts of the street. This special construction has to be carried the full width of the ties (8 ft.) and 6 ins. beyond on each side, making a total width of 9 ft. for a single track. As the railway companies now use T-rails instead of flange rails, this necessitates the use of a special type of brick on the inside of the rails, which is more expensive than the regular paving brick. The fitting of these bricks to the rails also involves additional expense in laying the pavements.

17. The presence of railway tracks requires an increased width of the pavement. This is necessary in order to permit traffic on both sides of a car. Our residence streets are ordinarily paved 24 ft. in width, but in

a street in which a single railway track is located, we consider that a pavement of 36 ft. in width is necessary. Under the present law the railway company does not pay the whole cost of this additional width. It would be most unjust to throw a greater share of the cost on the property owners when the necessity for the additional width results entirely from the use of the street by the railway company.

18. In repairing or connecting with water or sewer mains, it is often necessary to excavate under the tracks while cars are in operation at a considerable additional expense over what such work would cost in streets where there is no street car traffic. Property owners likewise in laying sewer or water laterals are burdened with similar extra expense.

19. The usual method of proceeding with paving work is by incurring a funded debt on the part of the city for its portion of the expense, and if the roadbed of the railroad company, which has a life of only about twelve years, is to enter into the issuance of bonds by the municipality, which usually extend over a period of 20 years, it will demand of the railroad company such a type of construction as will clearly outlive the issuance of bonds. Our experience with the methods of track construction used by street railway companies in paved streets, is that they are of an inferior character, and have subjected the city to an expense which would not have been encouraged had no tracks existed on paved streets.

20. In cities where large snow falls must be anticipated, the operation of snow plows and snow sweepers tends to break down the pavement between the rails. We maintain that the city should not be asked to correct conditions due to the operation of plows and sweepers.

21. It is fallacious to believe that the conditions existing today relative to the destructive influence of trolley tracks and the operation of trolley cars over them, is not the same as it has always been. The traction companies' false idea of economy, in general, has been a reduction of the first cost in ballasting of their tracks. This in conjunction with the rapidly increasing weight of cars, has extended the circle of influence of destruction more than 2 ft. outside the outside rail.

22. If the traction companies are relieved of this obligation, the increased cost of pavement and repair is thrown back on property owners by assessment for local benefits derived, or, if a general improvement, new revenue has to be obtained by an increase of the general tax. If it is a question of financing the work, surely the railroads, and indirectly the people who use them and benefit therefrom, should stand this cost, and not the entire community. Not over 50 per cent. of the population have occasion to use the railway, and it does not seem proper to ask those who derive no benefit therefrom, to help pay for the construction and repair which would be the case if there were a charge on the city.

23. The statute which it is proposed to amend is fair to the railway company in that the area of street pavement which it is now obliged to maintain is that area within which experience of many years has shown the street pavement is particularly affected by the maintenance and operation of its lines.

24. The presence of space between the tracks limits the surface area of the street available for traffic, and distributes over that portion of the street outside of "the dummy," more traffic than would ordinarily come on it, so that the practical result is that the railroad companies appropriate to their exclusive use that portion of the street between the tracks where the trolley poles have been installed betwen them.

25. In the borough of Manhattan in New York City all of the street surface railroad companies are operated with the underground electrical system which requires the installation of so called "channel" or "slot" rail in the middle of the space between the two rails of each track so that in the center of the space between the rails which, under the proposed bill, the city would be obliged to repair, we have a railroad structure the maintenance of which requires constant interference with the pavement between the rails and the tracks, and we have, further, manhole boxes, so-called, every few feet, approximately a foot square, the metal cover for which is located in the space between the slot or channel rail and rail of the track. These covers when placed opposite to each other on either side of the channel rail, as they frequently are, occupy almost the entire space between the two rails of the tracks. In the type of construction to which we have referred it will be readily seen that the pavement between the rails of the tracks is divided by the railroad structure into oblong strips or a series of small patches. These railroad structures tend greatly to diminish the life of the pavement. The traffic in the city of New York is very heavy and when the wheels of a heavily loaded vehicle pass from the metal structure of the railroad companies onto the pavement there is a grinding or wearing effect on the pavement which, being softer than the metal structure, is soon ground and worked away. Ruts, holes and depressions first appear in the pavement immediately adjoining the rails of the tracks and by the traffic are generally extended so as to include the entire space between the rails of the tracks and several feet outside of the outer rails of the tracks.

26. Snow and ice, cleared from the trackway, are thrown outside of the rail and often must be carted away by the city. With no tracks in the street, the snow ordinarily would remain evenly spread over the entire width of the pavement and not require removal.

27. Nine feet, a dimension controlled by the 8 ft. railroad tie should be definitely marked off by construction joints, and 9 ft. built and maintained by the railroad company. This places entire responsibility for damages due to subsequent failure within the railway strip where it belongs, since failure is due to railroad traffic.

28. If expense for pavement adjacent to rails and 2 ft. outside has heretofore been deemed a legitimate charge to street railway companies, a change is not considered justifiable now in the light of the usage of the heavy cars, higher speed and more frequent operation.

29. A railway company is constantly ripping up pavements to repair its street car tracks. It is absolutely impossible for a company, were it to maintain only 6 ins. in width on each side of its rails, properly to repair its tracks without disturbing other parts of the pavement, thus necessitating an added expense to be borne by the city.

30. The cities upon the faith of the performance by the street surface railroad corporation of their paving

obligations have granted many franchises on terms more favorable to street railroad corporations than they would have imposed had they not assumed that such railroad corporations would be obliged to pave the area described in existing law. If the liability on the part of the traction company existed then, there has been nothing that has taken place in the meantime to offset this liability, except to increase it.

31. The original purpose of this law was to place the burden of expense of this portion of the pavement upon the street railway company which enjoyed the privilege of the use of the streets to operate a business from which it derives a revenue. Nothing has transpired since the law was enacted which justifies a change which would place the burden of expense upon the taxpayer.

FEDERAL AID FUNDS WHICH MUST BE ABSORBED DURING THE FISCAL YEAR 1920 OR TAKEN UP

When the Congress of the United States made the first appropriation for Federal Aid for road-building, one of the provisions enacted was that the funds appropriated for any given fiscal year must be taken up within that fiscal year or the next one succeeding. It, therefore, transpires that once every year the question is raised as to whether all of the funds that have been made available have been absorbed by the States. During previous years this question has been of comparatively little importance because the amount of Federal Aid was relatively small and the probability of any State failing to take up its share, remote. However, when Congress added to the original appropriation the sum of $200,000,000 of which $50,000,000 was made available for the fiscal year 1919, and therefore had to be taken up prior to July 1, 1920, a real test of the ability of the States to absorb Federal Aid funds was established. It is not without significance that the States have taken up these funds more promptly than the smaller sums available during any previous year and that on June 16, 1920, the Chief Engineer of the Bureau of Public Roads signed the last plans and estimates needed in order to absorb the full allotment for the last States in the Union.

Table I which shows the amount of Federal Aid funds so far covered by plans and estimates is also of interest because it shows that, not only had all of the Federal Aid which had to be covered prior to July 1, been covered, but that a very large part of the 1920 funds have also been covered. Indeed this table shows that eight of the states have taken up all of the funds now available and that seven of these have obligated a portion of the funds that do not become available until after the first of July. This is, indeed, a wonderful showing and fully justifies the often expressed opinion that Federal Aid is appreciated by the States and is being absorbed fully as rapidly as the Federal Aid acts have contemplated.

Some impression of the rate at which Federal Aid is being requested may be secured from the following. During April new projects were submitted which called for Federal Aid amounting to $9,779,857.21 and plans and estimates were approved that called for $8,014,949.89 of Federal Aid. In May new projects were presented for approval that called for $7,719,689.15 of Federal Aid and plans and estimates were submitted on previously approved projects which required $16,656,872.35 of Federal Aid. During the first half of June new projects were submitted asking Federal Aid to the amount of $3,757,701.79 and plans and specifications were approved by the Chief Engineer calling for Federal Aid to the amount of $7,832,630.87.

The efficiency of the present organization of the Bureau of Public Roads can be no better indicated than by the fact that this enormous volume of business, amounting at times to the handling of requests for Federal Aid that amounted to more than a million dollars a day, has been transacted by the office of the Chief Engineer without the slightest delay and without omitting in any case, the necessary examination and correction of plans. Still better conception of the work of the Bureau of Public Roads and of the splendid organization which has now been developed can perhaps be had from the fact that while this work was being looked after the Bureau was also giving attention to the construction of more than 1,800 projects involving the building of some 18,000 miles of improved highways. This, in itself, is a tremendous operation demanding the careful attention of a large corps of trained engineers and the guidance of executives of the highest order. It may, therefore, be truthfully

TABLE I—STATUS OF FEDERAL AID FUNDS ON JUNE 16, 1920

State	Funds which must be taken up prior to July 1, 1920.	Funds obligated by plans and estimates approved by Chief Engineer of the Bureau of Public Roads.	Balance to be taken up prior to July 1, 1920.	Funds which must be taken up prior to July 1, 1921.	Balance which remains of funds to be taken up prior to July 1, 1921.
Alabama	1,676,167.27	1,714,967.74	0	3,671,669.07	1,956,701.33
Arizona	959,097.68	970,074.38	0	2,397,707.53	1,427,633.15
Arkansas	1,338,315.29	1,301,127.53	0	2,934,751.38	1,633,623.85
California	2,433,607.29	3,060,552.46	0	5,329,679.06	2,269,126.60
Colorado	1,375,920.25	1,450,904.21	0	3,024,304.97	1,573,400.76
Connecticut	492,552.43	981,823.05	0	1,075,975.27	94,152.22
Delaware	130,349.56	284,980.01	0	284,980.02	.01
Florida	912,449.89	1,476,917.40	0	2,002,664.56	525,747.16
Georgia	2,152,942.64	4,067,844.55	0	4,710,427.66	642,583.11
Idaho	974,371.32	1,003,107.46	0	2,134,338.93	1,131,231.47
Illinois	3,506,652.82	10,484,154.61	0	7,659,199.06	0
Indiana	2,163,392.46	2,330,279.49	0	4,728,239.34	2,397,959.85
Iowa	2,316,226.61	5,318,649.70	0	5,058,014.40	0
Kansas	2,295,068.00	4,888,460.41	0	5,024,064.45	135,604.04
Kentucky	1,562,265.53	3,614,538.29	0	3,418,309.36	1,803,771.16
Louisiana	1,086,908.29	1,918,464.93	0	2,380,293.44	461,828.51
Maine	771,393.47	1,056,827.77	0	1,685,733.41	628,905.64
Maryland	697,750.11	1,691,116.43	0	1,523,750.46	0
Massachusetts	1,179,698.00	1,600,470.81	0	2,579,776.26	979,305.45
Michigan	2,319,921.34	3,309,422.02	0	5,069,627.58	1,760,205.56
Minnesota	2,273,822.10	3,662,728.41	0	4,973,293.69	1,310,565.28
Mississippi	1,434,957.40	1,590,182.62	0	3,143,985.12	1,553,802.50
Missouri	2,713,079.31	3,049,093.49	0	5,934,176.11	2,885,082.62
Montana	1,592,849.60	1,508,854.18	0	3,491,837.18	1,982,983.00
Nebraska	1,706,399.75	3,451,947.98	0	3,733,019.67	281,071.70
Nevada	1,029,358.18	1,081,665.09	0	2,250,931.75	1,169,266.66
New Hampshire	333,410.35	790,690.56	0	728,250.06	0
New Jersey	949,046.06	1,454,849.23	0	2,077,742.57	622,893.34
New Mexico	1,273,633.77	1,307,676.17	0	2,791,326.76	1,483,650.59
New York	3,989,791.41	4,213,480.30	0	8,716,908.56	4,503,428.26
North Carolina	1,825,679.69	3,127,560.01	0	3,991,636.88	864,076.87
North Dakota	1,226,375.37	1,256,560.95	0	2,686,259.90	1,429,698.95
Ohio	2,973,222.17	5,446,803.36	0	6,496,700.90	1,049,897.54
Oklahoma	1,844,961.83	1,889,799.50	0	4,035,767.27	2,145,967.77
Oregon	1,259,853.95	3,320,163.83	0	2,756,026.23	0
Pennsylvania	3,678,154.13	9,624,353.12	0	8,040,698.24	0
Rhode Island	186,500.46	403,834.79	0	407,909.26	4,074.47
South Carolina	1,147,734.06	1,538,526.76	0	2,510,598.46	972,071.70
South Dakota	1,134,842.29	1,155,215.65	0	2,837,103.60	1,681,887.95
Tennessee	1,815,227.44	2,683,406.00	0	3,966,224.08	1,282,818.08
Texas	4,095,133.88	4,162,884.20	0	10,238,806.31	6,075,992.11
Utah	909,205.72	985,775.02	0	1,987,630.72	1,001,855.70
Vermont	362,650.02	476,240.16	0	792,026.64	315,786.48
Virginia	1,589,155.85	2,250,133.01	0	3,474,056.45	1,223,923.44
Washington	1,154,550.27	3,365,604.27	0	2,527,048.04	0
West Virginia	851,534.38	2,008,040.76	0	1,862,351.68	0
Wisconsin	2,040,736.92	2,208,988.16	0	4,459,335.32	2,250,347.16
Wyoming	980,308.68	1,447,678.68	0	2,144,842.33	697,163.65

stated that the organization of the Bureau has now reached a point of great efficiency both in administering the distribution of Federal Aid and in the Field Inspection of construction work and that through the efforts of the heads of this organization, Federal Aid is now being shown to be a complete success.

ADVANTAGES OF CENTRALIZED MUNICIPAL PURCHASING

By C. A. Bingham, City Manager, Watertown, N. Y.

The purchasing of all municipal supplies by one central office accomplishes many good purposes, and this article will deal with them, in the order of their value to the average municipality.

Eliminates Waste.

(a) The purchasing Agent keeps the perpetual inventory of all departments, as a check against overstocking, as well as under supplying.

(b) Each order is signed by the Auditor or Controller, and finally by the Mayor or Manager, thus centralizing the usual scattered responsibility.

(c) Transfers from departments over-stocked to those under supplied is better accomplished through one central office.

Eliminates Over-Drafts

(a) Every outstanding order is on record at all times, while without such centralization, thousands of dollars are in unrecorded obligations, thus preventing a true financial statement, as well as encouraging deficits toward the end of the year, to be passed on to the incoming administration.

(b) Prior to executive approval, each order is placed as an encumbrance against its particular appropriation by the auditor, like a certified check; thus making over-draft impossible, as well as insuring funds for its prompt payment.

(c) The executive who is held responsible for the City's finances should of course, have the executive control of the purchases, which cannot be efficiently carried out, when a score of departments do their own purchasing.

Secures Lowest Prices

(a) It is common knowledge, and most any seller will admit that centralized and combined purchases will bring lower prices and quicker deliveries, than many small purchases. There is abundant proof on record in our cities, where one department is paying 33 to 100 per cent. more for the same make of goods, than another department, and often even when purchasing from the same dealer.

(b) The average city takes a month or more to audit and pay a bill, not only losing all cash discounts, but also discouraging keen competition on quick turnovers, whereas by centralized purchasing, minus red tape, a bill can be paid in ten minutes, and special concessions of as high as 10 per cent. are frequent.

(c) By a systematic record of annual requirements for all departments, the purchasing agent is at all times prepared to clinch an attractive proposition, due to seasonal or market conditions, as well as arranging deliveries, so as not to tie up money unnecessarily, and yet assure a satisfactory supply at all times.

Reduces Expenditures

(a) By knowing that his executive passes on all requisitions a department head will not want to buy as much as he might, if he felt there was no check upon him.

(b) Efficient purchasing and inspection assures first grade of materials, as well as full measure—otherwise the seller knows he will receive no repeat orders.

(c) The joint knowledge and experience of the department head, the purchasing agent, and the executive often leads to either the securing of a better article on first cost or a substitute where the same would fill the need, while if the department head had to rely on his own decision entirely, the wrong selection might more often be the result.

Eliminates Graft

(a) If the purchasing agent is selected by merit, rather than by politics, he will be of the class above grafting. A real purchasing agent always has his advancement in view, and knows that one dishonest act will wreck his entire future.

(b) Sellers are generally afraid to even suggest graft to a municipal purchasing executive for fear of losing all future chances to sell to him.

Saves Taxpayers' Money

(a) The salary of the full-time purchasing agent is much less than the aggregate amount of hours wasted during a year by all the score of higher priced officials, who are forced to worry over such details in our average cities, not to mention the time lost from their real capacities.

(b) A large number of cities now maintaining centralized purchasing departments have proven that the 2 per cent. discount for payment of bills within 10 days, more than offsets the salary of the official. This 2 per cent. in 10 days is equivalent to 36 per cent. a year, but it is an unheard of and impossible proposition in the great majority of our American cities, simply because of antiquated systems, that no business concern would think of using.

(c) The trade discounts which are available, but are being passed up by our cities are astounding. In one city of under 40,000 these discounts totalled nearly $20,000 in one year; in another larger city it was $33,000, and in one of our second ten cities it was $100,000.

In General

In these days price is often the second question, delivery being of prime importance. Here surely none can deny the advantage of centralized purchasing. A follow-up system on all out-standing orders, a tickler on tardy invoices, a knowledge of available sources of supply, and lastly a constant touch on transportation, embargoes, etc., can not be compared with the lack of anything resembling system under the old order.

Forms play a most important part in efficient purchasing. First there is no need of the six to ten copy sets so often seen, for by a proper system several copies can be made to work double purpose. On the requisition, quotation and invoices the original and one copy only is

required; and for the other, the original and three copies will answer every need that can arise.

The forms for order, supply and quotation records, requisition index, etc., can all be accommodated on 4x6 in. cards. Not once in ninety times do we find need of more than ten double spaces on an order sheet, yet we find cities still wasting money on large and unweildy order forms. For filing purposes especially, all forms should be of uniform size, but of varying colors. Half letter size will be found to work best for all purposes, and as just one example can be cited the fact that several thousand invoices of that size can be vertically filed in a single small drawer, and always in immediate reach, while the cities still backing up vouchers of all sizes from 2 in. to legal cap, will soon have to use stepladders to do their filing.

The foregoing paper by Mr. Bingham was presented before the recent New York State Conference of Mayors and other city officials.

EFFECT OF HYDRATED LIME AND OTHER POWDERED ADMIXTURES IN CONCRETE

By Duff A. Abrams, Structural Materials Research Laboratory, Lewis Institute, 1951 W. Madison St., Chicago, Ill.

(Editor's Note:—A summary follows of the paper on this subject presented by Prof. Abrams before the annual convention of the American Society for Testing Materials held at Asbury Park, N. J., June 22-25, 1920.)

Studies of the effect of hydrated lime and other powdered admixtures in concrete have been under way in this laboratory during the past four years. About 20,000 tests have been made in six different investigations.

Compression tests of hand-mixed concrete were made on 6 by 12-in. cylinders in which hydrated lime was added in quantities up to 50 per cent. of the volume of the cement. In one series, tests were made with 17 other powdered admixtures. The mix varied from 1:9 to 1:2, with wide variations in consistency and size and grading of aggregate. The age at test varied from 3 days to 1½ years. Wear and bond tests were made in certain groups. Tests were also made with sand and slag cements.

Conclusions

The following are the principal conclusions:

1. In general the addition of powdered materials reduced the strength of concrete approximately in proportion to the quantity of admixture. Some exceptions are noted below.

2. In usual mixtures, each 1 per cent of hydrated lime (in terms of the volume of cement) reduced the strength of concrete 0.5 per cent.; 1 per cent. by weight of cement reduced the strength 1.2 per cent. The reduction in strength caused by replacing cement with an equal volume of hydrated lime was about 1¾ times that caused by adding hydrated lime.

3. High calcium and high magnesium limes produced the same effect.

4. The addition of 1 per cent of the following powdered admixtures in terms of the volume of cement reduced the strength of 1:4 concrete at 28 days by the following percentages: Brick, 0.08; clay, 0.22; whiting, 0.24; sand, 0.37; natural cement, 0.38; limestone, 0.39; lava, 0.40; fluorspar, 0.43; kaolin, 0.47; kieselguhr, 0.48; tufa, 0.51; hydrated lime, 0.56; ironite, 0.60; yellow ochre, 0.68; mica, 1.10; pitch, 1.50; gypsum, 4.00. For the same conditions the addition of 1 per cent. of cement increased the strength of concrete about 1 per cent.

5. Pulverized slag up to 50 per cent of volume of cement gave a slight increase in strength of concrete (about 0.12 on the basis used above.)

6. Rich concrete mixes showed a greater loss in strength due to powdered admixtures than the leaner ones. Very lean mixes (1:9 to 1:6) and in those with aggregates graded too coarse for the quantity of cement used, the strength was little affected or was slightly increased by admixtures up to 50 per cent.

7. The wetter mixes showed a greater loss in strength than the dry, due to the addition of hydrated lime.

8. The effect of admixtures was in general independent of the age of the concrete.

9. Sand and slag cements gave results comparable to those from powdered materials simply mixed in the concrete.

10. Hydrated lime and other powdered admixtures used in these tests slightly increased the workability of the leaner mixes (1:9 and 1:6) as measured by the slump test. Ordinary mixes (1:5 and 1:4) were little affected; richer mixes (1:3 and 1:2) were made less plastic.

11. The wear of concrete was not sensibly increased by hydrated lime or other admixtures up to 20 per cent. of the volume of cement.

12. The bond resistance was affected in the same manner as the strength by the presence of hydrated lime.

13. Hydrated lime had little effect on the absorption of dry concrete, increased the evaporation of water from wet concrete and produced no beneficial effect on the strength of concrete stored in air.

14. The yield of concrete was little affected by hydrated lime or other admixtures; for the usual concrete mixes, 20 per cent admixture increased the yield about 2.5 per cent.

LAST SECTION OF RICHMOND, VA.-WASHINGTON, D. C., HIGHWAY IMPROVED WITH GRAVEL ROADWAY

By C. S. Mullen, District Engineer, Virginia State Highway Commission, State House, Richmond, Va.

The particular interest attaching to Virginia Project No. 2 is the fact that it was the last section of the Richmond-Washington Highway to be improved.

For over ten years the Richmond-Washington Highway Association had been directing its energies to the construction of an improved road between Richmond and Washington, and by the year 1916 the entire route had been graded and surfaced except for a section just south of Woodbridge, about four miles in length. This section, designated as Marumsco Creek to Neabsco Creek was constructed as Virginia Project No. 2.

Agitation was started in December, 1916, to make this a Federal Aid Project under the new law appropriating

VIEWS OF VIRGINIA PROJECT NO. 2. BETWEEN RICHMOND AND WASHINGTON, D. C.
Right of Way Cleared—Roadbed Graded—The Gravel Roadway in Service.

Federal Aid for construction of post roads, and during the following spring of 1917 this work was urged as a measure of national defense to give the United States Marine Corps a satisfactory roadway for the transportation of supplies by trucks between Washington, D. C., and their base at Quantico, Virginia. With this added impetus the construction of this road was gotten through as Virginia Project No. 2 and construction started about the middle of the summer. Progress from the first was very slow and affairs eventually reached such an unsatisfactory state that the arrangements for carrying on the work were cancelled and all activities were suspended on December 6, 1917.

Early in 1918 the revival of this project was undertaken but it was not until the latter part of December, 1918, that satisfactory arrangements were made and a contract let to the S. E. Lee Construction Company of Emporia, Virginia, for the improvement of this section of road. The work included grading the entire project, building three small concrete bridges, putting in the necessary cross drains and underdrainage, and surfacing the roadway with gravel 16 ft. in width and 8 ins. in depth.

First Virginia Job to Use Government Trucks

One very interesting phase of this work was that it was the first job on which use was made of trucks which had been turned over to the State by the War Department. The contractor was supplied with four 2-ton Nash Quad trucks for which he paid a reasonable monthly rental. These trucks were equipped with dump bodies and the use of them was a distinct aid in carrying on this work.

Work under this contract was started early in January, 1919, and excellent progress was made, taking into consideration that the work was done during the hardest part of the winter.

Trouble With Gravel Supply

Under the terms of the contract this was to be completed by July 1, but during the summer considerable trouble developed in getting a sufficient supply of suitable gravel for the surfacing. Local gravel was used for the base but it was necessary to import gravel for the surface. A tie-up of the car service prevented an adequate supply of gravel being shipped in and after this shortage was relieved the character of the gravel received was not satisfactory and other arrangements had to be made. During this period an attempt was made to haul gravel from a pit seven miles away. Unfortunately the road over which this material was to be hauled was unimproved and in many places soft, due to springs, and the heavily loaded trucks soon buried themselves to the axle and this pit had to be abandoned, since it would have required too large an expenditure to put the road from the pit to the project in shape to haul over. Recourse was again had to gravel shipped in from one of the commercial pits in that section, and about the middle of December, 1919, the project was finally completed. Although opened to traffic in the middle of winter, this road gave good service and eliminated the worst barrier to automobile traffic between Richmond and Washington.

STANDARD 20 FT. CONCRETE SLAB BRIDGE UNDER CONSTRUCTION AND COMPLETED ON VIRGINIA PROJECT NO. 2.

SUGGESTED COMPOSITE SPECIFICATIONS FOR CONCRETE ROADWAY CONSTRUCTION

By S. M. Feinberg, C. E., Public Works Office, U. S. Navy Yard, New York, N. Y.

The following is a slightly modified copy of a specification the writer has prepared for a piece of concrete pavement and sidewalk construction. The specification as presented is a compilation from various up-to-date sources, such as the American Concrete Institute, the New York state and other state and federal authorities, supplemented by the personal experience of the writer.

It is the opinion of the writer that this is an iron-clad specification and it is offered to the profession through Municipal and County Engineering in the hope that it may prove of benefit to those interested in concrete roadway construction:

Clearing

Work Required—Work required includes the removal of all trees, old pavements, sidewalks, curbing, manholes, catch basins, flagstones, and any other material and appurtenances of whatever nature coming within the lines of the roadways and sidewalks that may interfere with the proposed work.

Removed Materials—Removed materials, with the exception of such as are hereinafter mentioned as reserved, shall be burned or otherwise removed from the ground as the engineer in charge may direct and without injury to adjoining property.

Reserved Material—All trees and branches over 3½ ins. in diameter, unless noted otherwise, shall be reserved for the city, and shall be trimmed of leaves and branches and piled to one side of the road as the engineer in charge may direct.

Movable Property—All movable property interfering with the construction of the roads and walks shall be carefully removed or piled up as directed by the engineer. No property shall be taken down except by the authority of the engineer.

Grading.

Work Required—Work required includes all excavation of materials and the placing of excavated materials in fill or backfill as directed by the engineer; the preparation of the subgrades so as to bring the surfaces to required grade (allowing for compression from rolling); also all similar work connected or appertaining to the construction of the roadways and sidewalks.

All fill material required in excess of that available from trenches, cuts, or from such other places on the premises as the engineer may direct shall be provided by the contractor.

Fill and Backfill—Fill and backfill shall be of good earth material free from vegetable matter and refuse. The use of muck, quicksand and spongy material that will not consolidate under the roller will not be permitted.

When the forms have been removed and the concrete thoroughly set, the contractor shall backfill along edges of all roadways, sidewalks and curbing to required grade. All backfill shall be thoroughly compacted and settled into place.

Preparation of Surfaces for Fill—All low places requiring fill shall be plowed or dug up to provide bond for fill if required by the engineer.

Surplus Excavated Material—Surplus excavated material shall be deposited by contractor where and as directed by the engineer at points within 500 ft. of its place of removal.

Subgrade—Subgrade for roadways and sidewalks shall be rolled by a power roller weighing not less than 10 tons. Use weight of roller desired to suit local conditions. After the subgrade has been carefully prepared, thoroughly compacted throughout and drained, all portions of the subgrade inaccessible to the roller shall be thoroughly tamped with a hand tamp weighing not less than 50 lbs., the face of which shall not exceed 100 sq. ins. in area. All soft spots that cannot be compacted by rolling must be removed and replaced with suitable material. If settlement occurs, the depressions should be scarified, filled and rerolled until the surface is solid, uniform and parallel with the grade of the finished pavement. The weight of the roller to be used for compacting subgrades for walks shall be as directed by the engineer.

Centers of Roads and Walks—Centers of roads and walks shall conform in aligment to the center stakes set for them by the engineer.

Material and Construction

Work Required—Work required includes the provision and installation of all materials necessary for the proper completion of the roadways, steps and sidewalks, in accordance with the drawings, this specification, and intent thereof.

Forms—Metal or wooden forms shall be free from warp, and of sufficient strength to resist springing out of shape, and shall be equal in width to the thickness of the pavement at the edges. Wooden forms shall be not less than 2 ins. thick and shall be capped with 2 in. angle irons. Where the roads or sidewalks abut building walls, side forms may be omitted at the discretion of the engineer, but a joint must be constructed between the road or sidewalk and the building wall.

All forms shall be well staked, braced, or otherwise held to the established lines and grade, with the upper edges on a level with the finished work.

All mortar and dirt shall be removed from forms before they are used.

Cross forms for sidewalks shall be either metal or wood, as follows: If of metal they shall be ¼-in. thick and of a depth equal to the full thickness of the slab; if metal cross forms are used the slab may be built to a form on each side and when the concrete has set the metal strip may be removed. If wood cross forms are used, every other slab may be placed and on setting, the cross form shall be removed and other sections placed.

Cinders—Cinders shall be clean, coarse, hard-burned cinders. No soft coal cinders will be allowed.

Materials for Concrete—Materials for concrete shall be in accordance with the latest American Concrete Institute specifications, unless otherwise noted. Fine aggregate and coarse aggregate shall be as specified hereinafter.

Reinforcing for Roadways—Concrete pavements 20 ft. or more in width shall be reinforced. The reinforcement shall have a weight of not less than 28 lbs. per 100 sq. ft. The ratio of effective areas of reinforcing members at right angles to each other may vary from 1:1 to

4:1. The spacing between parallel lines of reinforcing members shall not be more than 8 ins. A reduction of 3 lbs. from the weight specified may be allowed for those types of reinforcement not requiring extra metal at intersections.

Reinforcing metal shall be placed not less than 2 ins. from the finished surface of the pavement. The reinforcing metal shall extend to within 2 ins. of all joints, but shall not cross them. Adjacent widths of fabric shall be lapped not less than 4 ins. when the lap is made perpendicular to the center line of the pavement, and not less than 1 ft. when the lap is made parallel to the center line of the pavement.

The concrete above the reinforcement shall be placed immediately after mixing and in no case shall more than 45 minutes elapse between the time that the concrete below the reinforcement has been mixed and the concrete above the reinforcement is placed.

Reinforcing Rods for Steps—Reinforcing rods for steps shall be of "structural grade." They shall have the sectional area and spacing called for on the approved drawing. All rods shall be cleaned before embedding in concrete.

Integral Curb—The pavements and curbs shall be constructed in one operation, the whole forming an integral unit of the curved batter type, of dimensions as indicated on approved drawings. After the forms are removed, any stone pockets appearing on the surface shall be filled and the curb trowelled over with a wooden float after which a smooth and uniform finish of an approved type shall be secured.

At all points where new curbing abuts existing curbs a neat finish shall be provided. Where new curbs abut roadways without curbs, new curbs shall curve down to an approved radius.

Expansion Joints—Transverse expansion joints for roadways extending through curbs shall be not more than ½-in. thick, and they shall be spaced not more than 30 ft. on centers. All joints shall extend through the entire thickness of the pavement and shall be perpendicular to its surface. Joints shall be provided at changes of grade and at the junction of roadways and sidewalks with buildings.

Sidewalks shall be provided with ½-in. transverse expansion joints, the full depth of the slab, spaced as indicated on approved drawings and in no case more than 50 ft. apart.

All existing curbs, catch basins, manhole tops or other fixed objects which project through the pavement shall be separated from the concrete by joint filler.

Joint Filler—Joint filler shall consist of prepared strips of fiber matrix and bitumen or similar material of approved quality. The bitumen used shall be heated from 225 degrees to 250 degrees F. at the time of application. The joint material swabbed with hot bitumen on top shall extend through the entire thickness of the pavement and it shall be left projecting ¼-in. above the finished surface, before the road is opened for traffic. Care shall be observed in order to prevent the bitumen from speading over the suface of the pavement for a width of more than 1 in. on either side of the joints.

All bitumen used for joints or cracks shall be put on while hot and it shall be covered with clean, sharp sand.

Composition of Concrete—Concrete for roadways shall be mixed in the proportion of 1 part cement, 1½ parts fine aggregate, and 3 parts coarse aggregate. Fine aggregate for roadways shall consist of natural sand or screenings from hard, tough, durable, crushed rock, such as trap, granite, hard limestone or gravel, consisting of quartzite grains or other equally hard material graded from fine to coarse with the coarse particles predominating; when dry it shall pass a screen having 4 meshes per linear inch; not more than 25 per cent. shall pass a sieve having 50 meshes per linear inch, and not more than 5 per cent. shall pass a sieve having 100 meshes per linear inch. It shall not contain vegetable or other deleterious matter, nor more than 3 per cent. by weight of clay or loam. Routine field tests shall be made on fine aggregate as delivered. If there is more than 7 per cent. of clay or loam by volume in one hour's settlement after shaking in an excess of water, the material represented by the sample shall be rejected.

Coarse aggregate shall consist of clean, hard, tough, durable crushed rock or pebbles graded in size, free from vegetable or other deleterious matter and shall contain no soft, flat, or elongated particles. The size of the coarse aggregate shall be such as to pass a 3-inch round opening, and shall range from not less than 1½ ins down. Not more than 5 per cent. shall pass a screen having 4 meshes per linear inch and no intermediate sizes shall be removed.

The cement shall be amply protected from the weather and it shall be delivered for mixing only as required and covers shall be provided for its protection in case of a storm.

Modification of Composition of Concrete—The contractor may have the option to substitute other mixtures of concrete and other sizes for fine and coarse aggregates, providing a 28 days concrete made of such mixture shall have a compressive strength of not less than 3,000 lbs. per one square inch, as ascertained by approved methods, satisfactory to the engineer.

Consistency—Concrete materials shall be mixed for not less than one minute with only sufficient water to produce a concrete which will hold its shape when struck off with a template. The consistency shall be such as not to cause a separation of the mortar from the coarse aggregate in handling. The consistency of the concrete shall be determined by the following test: A cylinder 6 ins. in diameter and ins. in length shall be filled with concrete which shall be tamped until all voids are filled and a slight film of mortar appears on the surface. The cylinder shall then be removed and the vertical settlement or "slump" of the concrete noted. This settlement shall not exceed 2 ins. when a mechanical finishing machine is to be used and shall not exceed 4 ins. when the finishing is to be done by other methods. Materials shall be mixed in a batch mixer, as required in the latest American Concrete Institute specifications as mentioned hereinbefore.

Cross-Section—Cross-section of roadways and sidewalks shall be as called for on the approved drawings. Roadways and sidewalks, when completed, shall be true to the cross-sections, with sides parallel to the center lines and curved at intersections.

Proper superelevation, subject to approval by the engineer, shall be provided at all curves.

Underdraining for Sidewalks—Sidewalks shall be drained by 6 in. porous tile pipes, placed below the cinder fill and leading to catch basins. The porous tile pipes, free from cracks and other defects shall be firmly embedded in the cinders, being covered on the sides, top and bottom with clean gravel or broken stone.

Catch Basins—Catch basins shall be placed where indicated on the approved drawings and elsewhere where found necessary for proper drainage. They shall be constructed of concrete in accordance with approved details and shall be provided with cast iron slotted covers of an approved stock type.

Manholes—Brick manholes of an approved type, provided with iron rings, shall be constructed where indicated on the approved drawings.

Vitrified Tile Piping—Vitrified tile pipes, 6 in. and 8 in. in diameter shall be provided and installed where indicated on the approved drawings and elsewhere where found necessary for proper drainage. Vertical tiles under catch-basins shall be not less than 12 ins. in diameter.

Pipes shall be of single strength with standard sockets. Farm tile may be used if so desired. They shall be thoroughly hard-burned and vitrified inside and out, giving a clear, ringing sound when struck a sharp blow. They shall be free from cracks, checks, blisters, etc., that would impair the strength and durability, and shall be free from obstructions after being laid.

All pipes shall be laid straight and true to an even grade with open joints. They shall be surrounded on the bottom, top and sides with at least 6 ins. of broken stone or gravel, not less than ¾-in. in size and then backfilled with clean, coarse, hard-burned cinders.

Placing of Concrete for Roadways—No concrete shall be deposited in place until the finished surface of subgrade is satisfactory to the engineer. All work incident to the handling and depositing of concrete must be done in such a manner that the surface of the subgrade will not be cut up or depressions made on it.

Immediately prior to placing the concrete, the finished subgrade shall be thoroughly wetted, but there must be no pools of water, and muddy condition will not be allowed.

After mixing, the concrete shall be deposited rapidly upon the subgrade to the required depth in successive batches and in one continuous operation between transverse joints and for full width of roads without the use of intermediate forms between joints.

In case a mixer breaks down the concrete shall be mixed by hand to complete the section. Concrete in excess of that required to complete a section at the stopping of work shall not be used any more in the work.

A transverse joint shall be placed at the point of stopping of the work, satisfactory to the engineer.

The concrete for roadways shall be brought to the required contour from a bridge, no part of which touches the concrete, by means which will insure a compact, dense mass. All holes left on removing any material or device used in construction joints shall be filled immediately with concrete from the latest batch deposited. Special attention shall be given to the concrete at joints to see that it is properly compacted.

Under no condition shall more concrete be laid than can be completely floated before dark.

Finish for Roadways—Two methods of finishing may be used, machine finish and hand finish. In case machine finish is provided, the machine shall be of a type suitable for stiff concrete. In case hand finish is used, as soon as possible after the concrete has been struck off, it shall be rolled with an approved metal roller, having a smooth, even surface, approximately 6 ft. in length, not less than 8 ins. nor more than 12 ins. in diameter, and weighing not more than 100 lbs. On roads less than 20 ft. in width the roller may be operated with a handle which shall be at least 2 ft. longer than the width of the road, and all rolling shall be done from one side of the road. On roads or pavements 20 ft. and more in width the roller shall be provided with two bails, to which ropes shall be attached, and the roller pulled across the road or pavement. The roller shall be operated at such an angle with the center line of the road that it would advance along the road about 2 ft. for each time across. The roller shall pass from one edge of the road to the other, care being taken not to run the roller over the side forms in order to prevent earth or foreign material adhering to it. After the roller has covered a given area in the manner described, the same area shall be similarly covered by the roller for not less than three times at intervals of 15 to 40 minutes, and as many times additional as may be necessary in order to remove any excess water.

After the rolling has been completed the road shall be finished by two applications of a belt made of canvas or rubber belting, not less than 6 ins. wide and not less than 2 ft. longer than the width of the road. The belt shall be applied with a combined crosswise and longitudinal motion. For the first application, vigorous strokes at least 12 ins. long shall be used, and the longitudinal movement of the belt along the road shall be very slight. The second application of the belt shall follow immediately after the water glaze or sheen disappears and the stroke of the belt shall be not more than 4 ins. and the longitudinal movement shall be much greater than for the first belting.

The finished surface of the road shall not vary more than ¼-in. in 5 ft. from that called for on the approved drawing.

Any cracks, either longitudinal or transverse, that may develop before the acceptance of the work, shall be thoroughly cleaned out and filled with an approved bituminous material.

Placing of Concrete for Sidewalks—Sidewalks, consisting of 4-in. one course, concrete blocks mixed in the proportion of 1 part cement, 2½ parts sand and 5 parts stone, not more than 6 ft. square, shall be poured on a thoroughly compacted cinder bed of a thickness as indicated on the approved drawing. The cinder bed shall be thoroughly rammed and wetted before concrete is poured. The ¼-in. wearing surface shall be made integral with the base slab proper as hereinafter specified. Especial care shall be taken in finishing at expansion joints in order to have the surface at both sides of the joints at the same elevation. Under no condition shall more concrete be laid than can be completely floated before dark.

Wearing Surface—Wearing surface for sidewalks shall have a uniform thickness of 1 in. Before the concrete base has attained its initial set, there shall be placed

a wearing course consisting of a stiff mortar composed of 1 part cement, 2 parts of sand, and 1½ parts of crushed granite or stone of equal quality, subject to approval by the engineer, the largest particles of which shall pass through a ½-in. ring and the smallest retained on a ¼-in. screen, free from dust, loam, or earthly substances.

The smoothing up and finishing shall be done from a bridge no part of which touches the surface. After smoothing the wearing surface with a straight edge it shall be floated roughly with a plasterer's trowel, and after a few hours, when the mixture has begun to stiffen, it shall be floated with a wooden float and then with a trowel to a smooth even surface. No application of neat cement or of a mixture of cement and sand will be permitted. After the final floating, the wearing surface shall be grooved and jointed directly above the joints in the base, finishing the joint with a groover.

The sidewalks shall be sloped not less than ¼-in. per foot in order to shed water. The surface of side walks shall be roughened by dotting roller, should the engineer in charge so direct.

Steps—The contractor shall provide reinforced concrete steps where called for on the drawings. All fill shall be thoroughly compacted. The cement mortar finish for treads and risers shall be the same as for the sidewalks. Steps shall have a slight wash, as directed by the engineer, in order to permit water to run off. Reinforcing rods as hereinbefore specified shall be securely held in position while depositing concrete.

Curb Bars and Nosing—Curb bars, nosing or other protective appurtenances of an approved type, shall be provided where indicated on the drawings and elsewhere where necessary to protect exposed corners of curbs or building walls.

Curing and Protection—The concrete work must not be allowed to dry out too rapidly, and must be protected from the heat of the sun's rays by canvas covering. Sprinkling shall also be employed as soon as the concrete is hard enough in order to prevent the surface from being pitted. After the first day an earth covering not less than 2 in. thick should be employed. Such protection for roadways shall be provided for not less than two weeks', the exact time being determined by the engineer. Sidewalks shall be protected by moist canvas, supported above the surface by a suitable frame. Moist sand, or straw may be used in lieu of canvas. Either canvas, sand or straw shall be kept moist for not less than one week. At the expiration of the required time all covering shall be removed and the surface left clean.

The contractor shall erect and maintain suitable barriers in order to protect the concrete from traffic, and any damage to roads and sidewalks due to traffic or other causes or occurring prior to the official acceptance of the work shall be repaired or replaced by the contractor at his own cost and expense, and in a manner satisfactory to the engineer.

Inspection—The work will be conducted under the general direction of the engineer, and will be inspected by the municipal inspectors, who will enforce compliance with the terms of the contract. The inspectors will keep a record of the work done, but the presence of an inspector shall not relieve the contractor or his responsible agent of any responsibility for the proper execution of the work.

Loss or Damage—All loss or damage arising from any unforseen obstruction or difficulties, either natural or artificial, which may be encountered in the prosecution of the work, or from any action of the elements, or from any act or omission not authorized by this specification on the part of the contractor or any agent or person employed by him, shall be sustained by the contractor at his own cost and expense.

City Property—All material of value to the city removed by the contractor from present positions, shall remain the property of the city and shall be deposited by the contractor within 500 ft. where directed by the engineer.

Damage to City Property—The contractor shall take such precautions as may become necessary in order to prevent defacement or other injury to buildings and other city property. The contractor shall at all times protect all trees and shrubbery in the vicinity of the work under this contract and shall in no case remove any trees or shrubbery without the consent of the engineer. Any and all damages to city property resulting from neglect or carelessness by the contractor or his employees will be charged to him or shall be made good by him at his own cost and expense to the full satisfaction of the engineer.

Cleaning—After the protective coating is removed, the roadways shall be thoroughly cleaned before opening for traffic, and the protective material disposed of at points within 500 ft. of the place of removal, as directed by the engineer.

GOOD ROADS DECREASE COST OF LIVING

How much more vigorously would the newspapers of the country prosecute the nation-wide campaign for improved roads if they realized how inextricably good highways are linked up with the supply of newsprint paper!

When the misuse of our extensive forest lands began to approach the point of profligacy, the editors of the United States—one and all—shouted lustily, and with great effect, until Congress passed legislation to preserve the forests and thereby conserve the supply of wood pulp, without which paper cannot be manufactured. Now the publishers are experiencing a shortage of paper, and aside from the old cause, that the demand is greater than the

TEXACO ASPHALTIC CONCRETE LAID BY THE MURRAY CONSTRUCTION CO., ON SHERARD ROAD, COAHOMAS COUNTY, MISS. THIS VIEWS SHOWS THE VARIETY OF TRAFFIC THIS HIGHWAY CARRIES.

supply, one of the causes for the shortage and high costs is the difficulty and expense of transportation!

The problem is not that of educating the road building and engineering professions of the country to the necessity for good roads. But the problem is to educate the laymen and general public to the all-important bearing which improved highways has on the cost of living. As in the production of newsprint paper, so in the production and transportation of food-stuffs, fuel, lumber, and other commodities, modern highways play a role of inestimable importance.

Much time and effort has been spent in the advocacy of modern highways for main trunk lines joining centers of commerce and business. Of only slightly less importance, however, is the question of paving the principal side roads over which products must be transported to the main trunk highways.

Wood coming from the forests must first pass over the side roads before reaching the main highways; foodstuffs from the farms usually must be transported over roads other than the principal highways before reaching the cities. So one of the main problems which the road building profession faces today is the erection of suitable, durable, and high-type side roads. The reduction in the cost of haulage, the rapid transportation which saves food-stuffs from deterioration, and numerous other benefits more than pay for the cost of building the modern highways.

Nearly every State in the Union has "seen the light," and the counties and townships have begun to build durable roads. The State of Arkansas plans to build 629 miles of asphaltic concrete roads, and 660 miles of bituminous penetration work, in addition to considerable mileage of the temporary type. As an example of what counties are doing, Burlington County, New Jersey, will build this season 20 miles of modern sheet asphalt pavement, which will, added to the construction of last year, take care of the county's immense agricultural traffic between New York City and Philadelphia.

An impression of the value of modern pavements on the side roads of the country may be gained from the accompanying photograph of a road in Coahoma County, Mississippi. This picture shows the variety of traffic which the road carries, including everything from light and heavy motor truck traffic to the tremendously heavy iron-wheeled traffic of the mule-drawn lumber wagons.

AMERICAN ASSOCIATION OF ENGINEERS PASSES 20,000 MEMBERSHIP MARK.

The American Association of Engineers passed the 20,000 membership mark on July 27, 1920. The Association for some time has been the largest organization of engineers in the world, but attainment of this great number of members is of great significance in marking the continuation of the most rapid growth which has ever characterized an engineering society.

The association was organized in 1915—five years ago. At the beginning of 1919 it had about 2,300 members. At the beginning of 1920 it had 10,450 members. The growth in 1919 was 8,150 members; that in the first seven months of 1920 was 9,550. In other words, the association is growing about twice as fast this year as in 1919.

Since the first of the year 1919, the number of local chapters and clubs of the association has increased from 26 to 209. The national characteristics of the organization are fully borne out by the distribution of these local groups in almost every state in the union.

The American Association of Engineers has enlarged its national headquarters in Chicago from about 2,000 sq. ft. of floor space to over 6,000. It now occupies the entire sixth floor at 63 East Adams Street. District offices are maintained in New York, Washington, D. C., Pittsburgh, San Francisco and El Paso, Texas. A number of chapters in other cities also have paid employes and maintain offices.

The employment service of the association now fills an average of 300 positions a month, ranging in salary from $1,500 to $15,000 a year.

The official publication, Professional Engineer, established in January, 1919, has been received by the profession with enthusiasm and has a total circulation of 26,000.

In addition to National Secretary C. E. Drayer and about sixty assistants, the working force has recently been augmented by the appointment as director of field forces of Dr. Frederick Haynes Newell, formerly director of the U. S. Reclamation Service. Dr. Newell, who is head of the department of civil engineering in the University of Illinois, is in general charge of the development of existing chapters and clubs.

A feature of the growth this year is the establishment of state assemblies in several states. These are state organizations made up of the A. A. E. chapters and clubs in the state. Such assemblies are formed or in the process of formation in Ohio, Nebraska, Washington, Michigan, North Carolina, Wisconsin, California, Pennsylvania and Montana. The Michigan Assembly is built around the Michigan Engineering Society, which affiliated with A. A. E. last spring. Other societies to affiliate within the last year or so are the Southwestern Society of Engineers, now the Southwestern District of A. A. E., Oregon Society of Engineers, Engineers' and Architects' Association of Southern California, North Carolina Society of Civil Engineers, Northwestern Association of Highway Engineers, Idaho Society of Engineers, Engineers' Club of Kansas City, and others. As an example of growth of local societies following such affiliation the Southwestern Society has grown from 200 members to about 1,000 members.

ADVANTAGES OF THE GREAT LAKES-ST. LAWRENCE WATERWAY

By Edmund T. Perkins, V. P. Mississippi Valley Association, Consulting Engineer, 1211 First National Bank Bldg., Chicago, Ill.

Advocacy of the Great Lakes-St. Lawrence Waterway to the sea does not argue opposition to the Great Lakes to the Gulf Waterway but indicates an intelligent appreciation of the strategic situation and the necessity of all channels to the sea being developed and utilized to the

utmost. It should not be forgotten that partisan development dividing the United States into "the North" and "the South," aided greatly in making the great trunk railways develop east and west through the northern part of the United States with heavy grades into the troughs of the valleys and out again over the divides with wasteful and expensive operation, rather than all down hill across the Mason and Dixon Line to the ports of the Gulf of Mexico and the southeast Atlantic. Always partisan and provincial, some great little men of New York fear the development of the great Mississippi Valley and the West, unless under their wise control and for their personal profit. One of these opponents of the St. Lawrence project raises the alarm the soil of the west is exhausted. If this is true, why are the deserted and idle farms only in New York and the New England states? Should not these same vacant farms open the eyes of Easterners to the need of the development of every possible horse power of hydro-electric power along the St. Lawrence that manufacturing may restore to their states the prosperity that exhausted agriculture has taken from it?

The West and the Mississippi Valley must have its ways to the seven seas unhampered by the specious arguments of special pleaders.

The development of the interior of the United States, especially of the Mississippi Valley, is a matter of such magnitude that no individual should dare raise opposition. A liberal mind should realize the increase in national wealth means the increase in individual wealth. The opening of both the proposed waterways through the Great Lakes and the St. Lawrence to the sea and through the Ohio, the Illinois, the Missouri and the Mississippi Rivers to the Gulf of Mexico means just as much to New York and the east and to the gulf countries as it does to the states about the Great Lakes and directly west therefrom, and *fortunately most of the business men of New York and the East realize this.*

Today, undeveloped as it is, the Mississippi Valley is the center of production of every staple product of the soil that supports life and is the initial wealth producer. It is the center of production of cattle, hogs, sheep, horses, mules and the great American hen, one of the largest sources of wealth, and its products now are blocking all the transportation efforts of the railroads to the East and of the ports to which these roads lead. In a few years, a generation or two, with our desert lands irrigated, our swamp lands reclaimed, our hydro-electric power developed, our mines in full operation, there will be such a volume of production and traffic that all the railways, all the waterways and all the roadways will but illy serve to give relief. Cannot the doubting Thomases recall the Louisiana Purchase, Benton and the Great American Desert, the Alaska Purchase and all the other great adventures of the United States that were going to bring ruin and have only brought wealth and prosperity?

ADDENDUM

Centers of Production

"The Mississippi Valley has a present productivity in terms of percentage of the total:

Corn Production	65%	Flax Production	
Wheat Production	74%		Practically 100%
Cattle over	50%	Wool	47%
Hogs	57%	Coal mined	36%
Horses	60%	Coal Reserves	72%
Butter	54%	Copper	39%
Eggs	54%	Lead	46%
Cheese	57%	Iron Ore	85%
Apples	21%	Zinc	74%
Beet Sugar	53%		

"The course of the St. Lawrence is from the heart of the North American continent directly toward the principal part of Europe"—H. C. Gardner.

Undeveloped Resources

"The western and northwestern states have under cultivation from less than one-tenth to more than three-fourths of their tillable land. Yet the number of farms is increasing very slowly in some states or has been stationary for years in others. These and other figures show that they have reached or are approaching a condition of saturation under existing conditions.

"In Minnesota, for example, one-sixth of the land is under cultivation. If, 30 years from now, Minnesota makes a contribution to the other states of food supplies in proportion to its present surplus, there will be more than 35 per cent of its land under the plow. In varying proportions the same is true of the other states. This is the surplus food producing area of the United States. The population is increasing, the demand for food is increasing. The time has long passed when there can be any substantial increase in acreage in New England, the Middle States and some other areas. The increase must come in large part from the states of the lake territory. The resources are available; the increase in production to correspond cannot be read from past or present tendencies. The change in conditions must come by other means than a mere expectation of additional acreage. There is no such increase in sight under existing conditions."—Chas. P. Craig.

Transportation Shortage

"A. H. Groverman, representing the coal industries, declared at Superior that there was no coal shortage, and had been none in years, due to inability to furnish coal at the mouth of the mine. The mines can raise coal as fast as they can load cars; continuous operation is dependent on car supply. If this lakes-to-ocean route were open today,' he declared, 'the railroads could strike off one billion dollars from their estimates of needed equipment.'

"F. W. Holdredge, general manager of the Burlington, declared at Omaha that if the Burlington could deliver its tonnage at the Chicago terminal, it would double the carrying capacity of its present equipment."—Chas. P. Craig.

Manufacturing Supremacy

"Where are the engines?

"Seventy per cent of stationary prime movers are east of the Mississippi.

"Where is the power?

"Seventy per cent of the fuel reserve and water power are west of the Mississippi.

"What is the situation?

"The east is daily on the edge of a fuel famine.

"What of the future?

"The east is daily eating into its power reserves."—Robt. R. Dunn.

New York the Chief Beneficiary

"Recurring again to the power possibilities of the St. Lawrence, I venture to say that it is readily perceptible to anyone that of all the states bordering or tributary to this waterway the greatest beneficiary of the development will be the great Empire State of New York. The letting loose of this flood of power over her territory will cause her to leap to the front as a manufacturing state, and her products so stimulated by cheap power will find market in all the countries of the world. With her magnificent harbor and the superb advantage of her barge canal affording cheap water transportation thereto, and at the same time enjoying and possessing all the benefits of the St. Lawrence route, hundreds of miles nearer salt water than her western competitors, her high-value manufactures will have a permanent primacy over any other state of the Union. Indeed, it is no idle dream to picture her barge canal and her lake shore dotted with factories of all kinds in enjoyment of this 'white coal' at low rates in operation 365 days in the year, independent of season, their power coming into the factory on a wire instead of by rail and upon cars, free from labor, climatic, or transportation trouble or interruption. No other state of our Union has the same strategic advantage in power, population, labor supply, and transportation, and these advantages for natural and geographical reasons can probably never be lost; and this notwithstanding that the day is coming when the West will hold most of the black-coal reserves of the country in addition to her everlasting majority of the 'white-coal' supply."—Alexander T. Vogelsang, First Assistant Secretary of the Interior.

SOME POINTS TO OBSERVE IN DESIGN OF SEWERAGE SYSTEMS AND DISPOSAL WORKS

By Theodore Horton, Chief Engineer, New York State Department of Health, Albany, N. Y.

(Editor's Note:—The following paragraphs are from a discussion on this subject before a conference of City Engineers of New York State held recently at Jamestown, N. Y. Mr. Horton points out some features to be kept generally in mind by the city engineers of the State.)

Separate Systems for Sewage and Storm Water.

Sewerage systems of many of the older cities have unfortunately been constructed on the combined plan. I say unfortunately for several of these old cities are situated on smaller streams or bodies of water where combined systems are not appropriate and as a result have, in recent years, reached an embarrassing point where provision for future extensions and for interception and sewage treatment will be attended with greater expense and where future conditions resulting from storm water overflows will become more insanitary. My advice therefore in regard to all cities except perhaps a few situated along our larger rivers, lakes and tidal waters, is:

(1) To adopt the separate system as soon as possible and so far as practicable, since it will be more economical in the end with respect to both collection and disposal.

(2) In those cities situated on larger rivers where combined sewers have been built and are still in operation, and where extensions of them are permitted by the State, to see that no combined sewers are built in any outlying section which would now, or in the future, involve overflow into any small tributary of the main river.

(3) To design all sewers and sewer outlets, either separate or combined, so that they may be properly intercepted in the future by main intercepting or outfall sewers that may be carried to properly located sewage disposal works.

Capacities, Sizes and Grades of Sewers

In the design of sewers a simple and safe rule that may be followed is to allow approximately 300 gals. per capita for the population to be served, designing lateral sewers to run one-half full, and intercepting and outfall sewers to run full. These rates will generally take care of daily and seasonal fluctuation in rate of flow of sewage; and, if minimum grades are carefully observed which will provide ordinarily velocities equal to 2.0 ft. per second, and in no case less than 1.5 ft. per second, running full or one-half full, little difficulty will be experienced in operation or maintenance.

Manhole, Flush Tank and Siphons

The use of manholes along sewers is generally conceded absolutely necessary whereas the use of flush tanks is largely optional. Manholes should be spaced at intervals of about 300 ft. and never over 400 ft. apart except on large sewers. Manholes should also always be placed at points of changes of grade and alignment. Where slopes are very steep, drop manholes are advisable.

The use of flush tanks at the head of all sewers laid on minimum grades should be considered compulsory. Elsewhere their use is optional, keeping in mind, however, that where not installed, flushing by hand should be done occasionally and at least once yearly.

Inverted siphons should ordinarily be avoided but should not entirely be shunned. Their design is very important and better practice sanctions at least two lines of siphon pipe. I would suggest also that the cross section of all channels of flow, especially the head houses, be restricted in area in order to keep the velocities well maintained and the channels free from accumulations of sludge and grease.

Sewage Disposal Works

This subject is obviously too broad to cover by a discussion. As already pointed out, also, it would be impracticable to lay down hard and fast rules since each case must be considered an individual one and be determined in the light of local conditions and requirements. While ideas on the subject have changed very considerably in recent years, opinions among experts today are, however, quite agreed upon many essential points. Many engineers at the present time seem to overlook the essential fact that sewage disposal works are not designed primarily for the purpose of keeping streams pure for drinking purposes, but more to keep them in a sufficiently clean condition to prevent a nuisance. In fact it is only rarely that disposal works are designed to protect water supplies and even then it is usually to prevent any undue burden upon a water purification plant that may be situated below on the stream.

The requirements to be made in any case are not a simple matter and require careful study and fine judgment. Generally speaking, the policy of our Department

is at present to demand only such degree of purification as will meet the fundamental requirements already stated. In fact while I have frequently shocked applicants for approval of sewage disposal plans by demanding a higher purification than they have endeavored to get away with, I have on the other hand occasionally shocked one by frankly telling him that the degree of purification sought was unnecessarily high and wasteful. In brief, protection of health and freedom from nuisance must obviously be the appropriate end sought, and the aim of our Engineering Division is to see that this principal is observed but not abused; and with this end in view I feel sure we have the support of all.

Concerning sewage disposal design I feel quite convinced that simple, positive and reliable methods of treatment are preferable to those methods which are yet in an experimental stage or which have not been proven efficacious in practice or economical and simple in operation. I do not mean by this that I endorse the old-fashioned flat bottom settling tanks, not even septic tanks, in view of better and more effective types; but I do mean to warn against the installation of expensive and elaborate types until these systems shall have proven their efficacy and reliability through wide applications and experience.

At the present time sewage screens seem destined to play a more important part in sewage disposal than formerly and improvements in design and mechanism are rapidly increasing. Tanks of the two-story type, or of the plainer Hopper bottom type, have proven both effective and economical and, properly designed, eminently suitable for preliminary treatment. Contact beds though still applicable to some local conditions, seems not to be as efficient or adaptable as sprinkling filters. Sand filters still hold, and probably will continue to hold, the highest place in sewage treatment where a high degree of purification is demanded. Activated sludge treatment while concededly practicable, seems still to have inherent features which are difficult to control and much hesitancy still exists among experts in recommending this treatment except under special conditions. Sewage disinfection, while offering a limited field of application, is an invaluable method of treatment where bacterial purity is required; and may often be advantageously used in combination with tank treatment alone or as a final and finishing process to filtration where water supplies, shellfish or bathing beaches are to be protected.

One feature in regard to this subject which I particularly desire to stress is regarding maintenance. I refer not so much to the sewers as to the disposal works which in most cases have been constructed at considerable cost and the benefits from which, in many instances, have been largely nullified by careless operation and in some cases absolute neglect. If these disposal works are worth building at all they are certainly worth operating and if civic pride and sound business policy is not sufficient incentive to induce proper operation of these works when once built, I am sure that the State Departments of Health and Conservation are justified in taking suitable action to force it. In this attitude I feel that we should have the support of city engineers for after all, the question is one that affects every municipality in the state either directly or indirectly, and the views and opinions of city engineers, carry more weight in matters of this kind, than those of other persons or officials in the community.

CO-OPERATION BETWEEN ENGINEERING SOCIETIES AND EDUCATORS IN STANDARDIZING ENGINEERING EDUCATION.

By J. H. Dunlap, Associate Professor of Hydraulics and Sanitary Engineering, College of Applied Science, State University of Iowa, Iowa City, Iowa

(Editor's Note:—In his paper before the recent annual convention of the Society for the Promotion of Engineering Education, Professor Dunlap presented a strong case for the broad standardization of engineering education through co-operation between engineering societies and educators. Going back about 20 years, he pointed out that in the academic year 1898-99 only 14 per cent. of the medical schools required for admission more than a one-year high school course, as compared with 33 per cent. of the law schools and 80 per cent of the engineering schools. Moreover, 91 per cent of the medical schools had a four-year course with an average of 28 months in attendance, as compared with 98 per cent. of the engineering schools with an average of 35 months in attendance. The law school course was much briefer than that of either of the others. Accordingly, 20 years ago the requirements for admission to engineering schools as well as the length of course greatly exceeded those of the law and medical schools. The same tests applied at the present time show changes decidedly unfavorable to the engineering schools, as the following extracts from his paper show conclusively.)

The medical schools, 20 years ago at the bottom, are now at the top; while the engineering schools, 20 years ago at the top, are now at the bottom, with the law schools in a middle position. Furthermore, the leading dental colleges will require in 1921 one year of liberal arts college credit for entrance to the four-year dental course. Moreover, the graduation requirements of the leading schools of theology now consist of a four-year liberal arts course, plus a three-year theological course. Accordingly the engineering colleges, requiring four years of study in addition to a four-year high school course, are now fifth on the list of professional colleges. Indeed it is very doubtful if they should be classed as professional colleges at all. There is certainly much justice in classifying technological schools in the reports of the United States Bureau of Education with universities and colleges, while schools of medicine, law, dentistry, theology, pharmacy and veterinary medicine are classed together as professional schools.

Advances Made by Other Professions

These advances have not been brought to pass by the medical, legal and dental professions without great effort. After years of work the Council on Medical Education of the American Medical Association has prescribed standards by which medical schools are now classified into A, B and C classes. The State Medical Examining Boards have co-operated voluntarily, by deciding that they would accept only graduates from recognized schools. As a result of this policy, there are now 85 recognized medical schools, 78 of which require two years or more of work

in the liberal arts college for entrance to the medical course. Furthermore, eight schools are now requiring, in addition to two years' work in a liberal arts college, and a four-year medical course, a seventh year as interne before granting the degree of M. D. In addition to the standardization of medical schools, a model curriculum has been prepared.

In the case of law schools, rapid development is now taking place. Among the 50 law schools holding membership in the Association of American Law Schools, about 20 now require two years or more of liberal arts work for entrance to the law course of three years or more. The American Bar Association is at work on the problem of standardization of law schools. It is expected that the meeting of the Association at St. Louis this summer will initiate a plan which will accomplish this end.

It is interesting to note that the curricula of the law schools have followed so closely the leadership of the law schools at Harvard and Columbia that there is no need for a model curriculum.

In the case of the dental colleges, the Dental Faculties' Association of American Universities and the Dental Educational Council have been engaged for some time upon the problem of standardization of dental schools. In 1921 the dental colleges holding membership in the Dental Faculties' Association of American Universities will require one year of liberal arts work for entrance to the four-year dental course. It is expected that this requirement will be raised later to two years' liberal arts and four years' dental work. The final step is expected to be a seven-year course with combined work in the liberal arts college, the medical college, and the dental college.

Certain immediate effects of the higher graduation requirements of the medical, legal and dental schools are obvious. In the first place, the more thoughtful and resourceful students, other things being equal, will be attracted to these professions by the fact that they are apparently of higher grade than the engineering profession. In the second place, the students who come to a university as they would come to a trade school, with the purpose of finding the shortest cut to a fairly respectable job that will provide them a living, will be attracted to the engineering profession. In addition to these immediate effects, it is not difficult to forecast something of the ultimate result of the competition for leadership in a given community between graduates who have been broadly and thoroughly trained in the medical, legal and dental schools, and graduates who have been narrowly and superficially trained in the engineering schools. We will all agree that engineering schools should be, and are, consecrated to the task of fashioning a human product which shall lead our communities into ways of keen analysis of their problems, and the economic execution of every kind of project. But without the broadest and most thorough training, will such leadership be gained by the engineering profession?

A clear statement of the issues involved is contained in the following statement by Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment of New York City:

> The head of a large industrial corporation, who was also the chairman of a board of trustees of an engineering school and was urging the broadening of engineering education, put the case in this way: "We can get plenty of men who are technically competent, who are careful and thorough in their investigations, whose conclusions we know to be sound, but who cannot make a favorable impression before a board of directors. We can get plenty of lawyers who, after being coached by our engineers, can glibly and even convincingly talk to the same board of directors until some question is asked which has not been covered in the process of coaching, when they too will flounder about. If we can secure a man who possesses the conscientious thoroughness and accuracy of the engineer, and also has the facility of expression and persuasiveness of the lawyer, what is a salary of $25,000 or of $30,000 for such a man?"
>
> He therefore urged that this particular school, instead of trying to turn out a large number of $2,000 to $5,000 men, give to the profession a limited number of $25,000 to $30,000 men.

In this connection one cannot help inquiring to what extent the prevailing complaint against underpay by the engineering profession, both practitioners and teachers, is due solely to the faults of the individuals themselves in not possessing the qualities of leadership which are always held at a high premium.

Factors in Standardization of Engineering Schools

With engineering schools at the bottom of the list so far as requirements for graduation are concerned, it would seem that it is high time for the development of a comprehensive plan for the standardization of engineering schools and of their curricula. The following factors are suggested as of possible importance in such a plan for standardization. The factors are based to a large extent upon the present schedule for grading medical schools.

1. Length of curriculum including requirements for entrance, etc.
2. Character of curriculum, grading of courses, sequence of subjects, supervision, administration, etc.
3. Engineering school buildings, adaptability, heat, ventilation, cleanliness, etc.
4. Laboratory facilities.
5. Co-operation with the industries.
6. Student organization and extra-curriculum activities.
7. Full-time instructors and assistants with special references to their qualifications and evidences of their work including research.
8. Faculty, number, qualifications and organization.
9. Library, museum, charts and special apparatus, and evidences of the use made of them.
10. Showing of graduates at state board and other examinations, and other evidences by which the training received is indicated.

Of course the preparation of a model curriculum would be one step in the process of standardization.

Objections to Standardization of Engineering Schools and Curricula

Objections to any proposition for standardization of engineering schools and curricula may be expected. When the combined liberal arts and medical course was proposed, such a plan was pronounced by one disting-

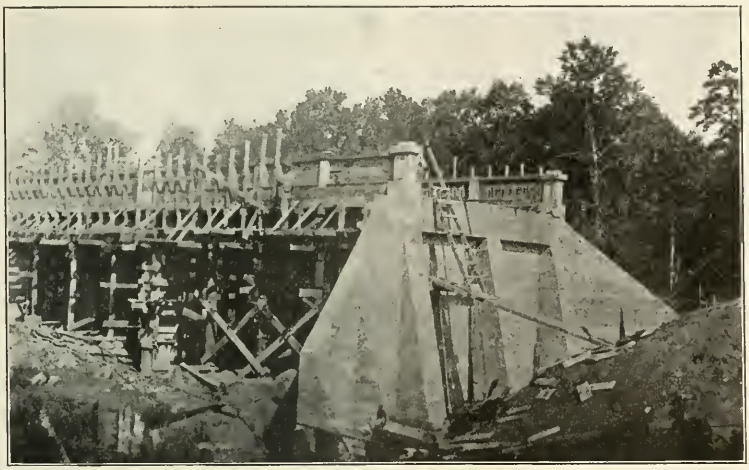
uished educator to be pernicious; by another, "to be a very dangerous process, that indeed there is no more alarming process now going on in the United States in regard to education than this." Associations of College presidents protested against it, and resolutions to prohibit the practice were considered by the board of regents of the University of the State of New York. The lengthened course was declared to work a hardship upon the poor boy who wants to get an education. The unanswerable question was propounded, "Who will practice at the country crossroads and the backwoods districts if a thorough medical training is insisted on?"

Two possible objections to the project under consideration may be briefly discussed. In the first place, it may be objected that standardization will mean stagnation in engineering education rather than progress. The practical answer to such an objection is the experience of the medical schools of the United States. Standardization in the sense that all institutions would be in the same lock-step is not intended. For instance, it is said that no medical school in the country conforms to the model curriculum prepared by the American Medical Association, and yet every medical school is profoundly grateful that such a model curriculum has been prepared. By such standardization as is contemplated, sufficient elasticity would be provided so that the individualities of the various schools would not be unnecessarily interfered with. By frequent revision of the standards, progress made in any direction anywhere would become quickly available everywhere. The individuality of different teachers would be reflected in the different content and length of the several parts of the curriculum of any institution.

A second objection, more real than the first, is that additional requirements for graduation will decrease the number of graduates, and that at the present time there is a great under-supply of engineers. If there is at the present time an under-supply of engineers, the advertisements for positions wanted in engineering periodicals and the activities of the employment agencies seeking employment for engineers give an erroneous impression. Such increases as have been made in the requirements in the past have not had the effect of greatly curtailing the number of engineers. The law of supply and demand has worked very well in the past and may be expected to in the future. At times there will be a scarcity of engineers, and at other times as we all know, there will be a great surplus.

The Next Step

President Hollis, in his address before this Society last year, on "Engineering Colleges and Administration," gave as one of his conclusions, "that the national engineering societies should be asked to co-operate not only with this association, but with the colleges themselves toward broadening out engineering education." In harmony with this suggestion and with the facts stated in this discussion, it is believed that this society should appoint a committee on curricula of engineering schools to co-operate with the existing committee on curricula of engineering schools of Engineering Council, the membership of which consists of Alexander C. Humphreys, Chairman, D. S. Jacobus, Edwin Ludlow and Comfort A. Adams. By the co-operation of these committees, a plan could be devised to bring about such a degree of standardization as will fit the present situation, and will prepare for future developments in further co-operation and standardization.



CONSTRUCTION VIEW OF WEST ABUTMENT AND PART OF CONCRETE STRUCTURE, FLINT RIVER BRIDGE.

THE FLINT RIVER BRIDGE, MACON COUNTY, GEORGIA.

By W. R. Neel, State Highway Engineer, Walton Bldg., Atlanta, Ga.

One of the largest and most satisfactory highway improvement projects in the state of Georgia is known as Federal Aid Project No. 7, in Macon County. It has a

VIEW OF CONCRETE APPROACH TO FLINT RIVER BRIDGE, MACON COUNTY, GEORGIA.

total length of 4,700 ft., and 1,540 ft. consists of a concrete approach to a steel bridge of three riveted truss spans of 120 ft. each, making a total bridge length of 1,900 ft. The total cost of the completed project is $169,467.

This structure crosses the Flint River, near Montezuma, Georgia, in what is known as the peach belt. It has been under construction for slightly over a year. A view of the west abutment and a part of the concrete structure is shown herewith. There is also shown a close view of the approach of the structure, and a side view of the new structure, in which the old bridge structure can be very clearly seen. The difference between the old and new structures will be noted with interest.

The project, as stated, consists of bridges and approaches connecting Montezuma and Oglethorpe. The Flint River, like others in this vicinity, rises rapidly during rainy seasons. During the period of high water it floods large portions of the surrounding country and then gradually subsides.

The concrete viaduct consists of two-column bents supported on wooden piles. The deck consists of five girders of 35-ft. span, supporting a 9½-in. concrete deck, which is covered with a surfacing of Kentucky Rock Asphalt, 2 ins. thick and 17½ ft. wide. The spindles and rail of the railing are of pre-cast concrete construction. In the railing ⅝ in. expansion joints were placed at every other span. Some cracks developed in this hand-rail because the expansion joints were not kept in the same plane.

No other difficulties of importance were encountered in the work and it is believed the structure will be a permanent monument to the zeal and efficiency of the engineers and contractors involved. This was the first structure of any magnitude completed under the new regime now prevailing in highway affairs in Georgia. The work was characterized throughout by a spirit of co-operation on the part of all concerned, which promises much in the way of substantial, permanent crossings to carry modern traffic across the many streams of the state which now make some parts of it inaccessible at certain periods of the year.

The plans for this structure were prepared by Garrett & Slack of Montgomery, Alabama, under contract with the State Highway Department. The project agreement with the Bureau of Agriculture was executed August 4, 1918, and modified Oct. 6, 1919, by which the state secured Federal Aid to the amount of nearly $85,000.

The contract for 3 riveted steel spans of 120 ft. each, with accompanying pier-work, was let to Austin Brothers Bridge Co., of Atlanta. The concrete work of 1,540 lin. ft. of reinforced concrete bents, deck and railing was awarded to the Nichols Contracting Co. of Atlanta. The Nichols Contracting Co. also had the contract for making the earth fill of approximately 54,000 cu. yds.

ASPHALT WORK IN PROVIDENCE, R. I.

By M. M. Cranston, New England Division, Asphalt Sales Department, The Texas Co.

The Board of Public Works of Providence, Rhode Island, has begun work on this season's paving program. The sheet asphalt work is being done by the Narragansett Improvement Company, and in addition to this there will be approximately 90,000 sq. yards of asphalt penetration work.

Most of the sheet asphalt will be laid on a 6-inch cement concrete base, using a 1½ inch binder and a 1½ inch top. It has been found here that on certain streets a 6-inch compressed gravel base makes a stable and satisfactory foundation, and therefore some of the sheet asphalt will be constructed on this type of base. Where it is necessary to repair the older sheet asphalt construction that has undergone years of heavy traffic, a crushed stone base penetrated with asphalt will be used.

The penetration work to be done will consist for the most part of about 3 ins. of clean crushed stone applied

VIEW OF THE THREE STEEL SPANS OF THE FLINT RIVER BRIDGE, MACON COUNTY, GEORGIA. THE OLD BRIDGE STRUCTURE CAN BE CLEARLY SEEN.

Waterbound macadam road looking north from village of Saugatuck, Michigan, treated with "Tarvia-B" in 1917, 1918 and 1919.

West Michigan Pike, near village of Douglas, Mich. Waterbound macadam treated with "Tarvia-B" in 1917, 1918 and 1919.

Inset: Waterbound macadam road near South Haven, Mich., patched with "Tarvia-KP" and treated with "Tarvia-B" 1918, 1919.

West Michigan Pike, Van Buren County, Michigan. Waterbound macadam roadway treated with "Tarvia-B" in 1918 and 1919. Part of a 15 mile stretch of Tarviated roadway.

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And all around them are miles and miles of old gravel and macadam roads, not in themselves equal to traffic conditions, but which can be made serviceable if they are repaired and given a Tarvia treatment.

Some Michigan roads, illustrated herewith, show how easily and economically old roads can be salvaged with Tarvia.

One road, for instance, was so bad that the Township Board decided the only thing to be done was to rebuild it at the cost of a new road, but after seeing results obtained on other roads, decided to patch and treat with "Tarvia-B" and stone chips, and—"*the road is better than when new*," they say.

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"Tarvia-KP" is a cold treatment for patching existing roads of every type. It fills up worn places, restores broken shoulders and edges and keeps the road always at the top notch of condition.

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This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

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to the existing foundation, and then this will receive an asphalt penetration treatment, which has been giving uniformly satisfactory results in Providence during past years.

ONE-MAN CONTROL SPEEDS IDAHO ROAD BUILDING

The greatest development in Idaho's road building program has come since the work was placed under the complete control of one man, the Commissioner of Public Works. Since his appointment in April, 1919, three times as much work has been accomplished as was done by the State Highway Commissions in the six years of their existence, says the Idaho Highway Bulletin for July 15, 1920.

When the State Highway Department was organized in 1913, the work was placed under the direction of three commissioners, living in widely separated parts of the state. Later on the personnel of the commission was changed, but there were still three members, and important business had to wait until the commission could get together. In many instances considerable time was lost before a meeting could be held to decide on questions of policy.

In the early years of the Highway Department, all work was paid for by the state and counties or highway districts. The Federal Aid Act was passed in 1916, but did not become effective in any state until the legislature passed a cooperating act. Idaho did this in 1917, and in 1918 a small amount of work was done in Custer County. However, it was not until the Spring of 1919 that the full road program of the state was well under way.

Governor Davis, recognizing the difficulty of handling the work effectively with three directors, abolished the State Highway Commission and placed the entire administration of the department in the hands of a Commissioner of Public Works, who was held strictly accountable for the efficiency of the Bureau of Highways. Politics were barred absolutely from the department, and a first class organization has been built up to handle the road program of 1919 and 1920.

Under the State Highway Commission it would have been impossible to carry out this large volume of work without vexatious delays, and frequently without serious financial loss to the state. With one man in direct charge, empowered to act instantly on any proposition brought before him, these delays have been eliminated.

The program for 1921 and 1922 will overshadow the work of the past biennium, both in magnitude and in its importance to the people of the state. It is absolutely essential that the present system of administration be continued, in order that this construction may be handled promptly and efficiently. No three men, no matter how able each may be, can carry on the work as effectively as one man who can keep in close touch with the details at all times.

When the Department of Public Works was created by Governor Davis, The Bureau of Highways was a very small organization. The War had made highway construction next to impossible, but the boys came home in 1918 and conditions seemed to be getting back to a normal basis early in 1919. It was necessary to build up a large engineering organization to handle the proposed road program. During 1919 much of the time was spent on necessary preliminary work, making surveys, preparing plans and estimates, and getting ready for a great deal of construction in the latter part of 1919 and in 1920. The large amount of work now under construction vindicates the wisdom of the careful preparations made during 1919.

CONCRETE FORDS GIVE SATISFACTION IN IOWA

Winneshiek county, Iowa, in meeting a difficult bridge situation will experiment with a concrete ford instead of the ordinary bridge structure. The site is on a township road little used and in bad condition, yet it is necessary that some sort of crossing be provided at the location. The drainage area is about 5000 acres of very hilly land. The run-off following rain storms is extremely rapid, making it necessary in case a bridge of the ordinary type were built to provide a very large waterway.

Upon the suggestion of District Engineer, J. W. Mercer, of the Highway Commission, County Engineer Arneson, plans to build a concrete ford providing a waterway beneath only sufficiently large to allow for the ordinary flow of the creek. The high water at the time of floods will pass over the top of the ford. This creek raises and falls very quickly and it is seldom more than a couple of hours after reaching high point until the water is again down to normal. The location is such that there is no time during the year but that the ford could be used if the other part of the road in its present condition was usable.

This will not be the first use made of the concrete ford in Iowa, but the examples of this kind are so few that they are worth mentioning. Wherever tried out they have proven very satisfactory, says the Service Bulletin of the Iowa Highway Commission.

CONCRETE SIGN BOARDS FOR ILLINOIS MAIN HIGHWAYS.

Illinois has adopted a concrete sign for main highway routes. The head of the post is 4 ins. thick, 12 ins. wide and about 20 ins. high. The outline of the state is grooved in the material and then painted in black. The number of the highway appears at the top of the sign. A third figure below indicates the location of this marker in the system and this corresponds to the number which appears upon the state map indicating that particular point on the map. This number indicates the approximate mileage from eastern and northern terminals of the route. The letters "L" and "R" are used to indicate left and right turns. The posts have a total height of 8 ft. and are embedded in the shoulder of the road to the depth of 3 ft. so that the post stands 5 ft. above the ground.

WATER WORKS SECTION

ICE TROUBLES IN THE ST. LOUIS, MO., WATER WORKS

By Cornelius M. Daily, Engineer in Charge, Supply and Purifying Section, Water Division, St. Louis Department of Public Utilities, 34 East Grand Ave., St. Louis, Mo.

Since 1895 the St. Louis water supply has been taken from the Mississippi River at the Chain of Rocks, and from that date trouble has been experienced, every severe winter, with ice entering the supply tunnel and lodging in the wet well from which the pumps draw their supply.

The old intake tower is located 1,500 ft. west of the Missouri shore in the deep channel, where it acts as a buffer to floating ice, and the ports are now protected from ice entering them with only a floating timber boom. The new intake tower is located about 500 ft. farther east than the old one. The ports are not protected in any way against the admission of ice.

Ice Troubles from 1901 to 1917

The problem of preventing the ice from entering the supply tunnel has been given much thought by all Water Commissioners and their assistants since the plant was put in operation, as shown by the following extracts from the Water Commissioner's annual reports:

1901.

"In my report last year I referred to a timber floating boom which was placed at the inlet tower to fend off ice in winter. Our first winter with this boom showed it to be very useful in turning the main body of running ice away from the intake. There is, however, another trouble which comes from ice and which our present arrangement of boom and curtain barge does not meet. When the temperature approaches zero the water of the river is full of minute crystals of ice. These will go where the water does. In our plant they pass through the tower and tunnel to the wet-well. In the wet-well the crystals rise to the surface forming mush ice. Until a year ago this ice was removed from the well by thawing out with steam pipes. The amount of steam used in this way was at times very great, more steam being used for this purpose than for running the pumps while the trouble lasted. To avoid this strain in our steam plant, a scheme was devised to remove the mush ice from the wet-well by means of an endless chain elevator, driven by a small steam engine. The scheme was executed successfully. The machinery was assembled in December, 1900, and was ready for service on Jan. 15, 1901.

"On Jan. 23, 1901, it was tested and found to remove the mush ice at the rate of about 10 to 15 cu. ft. per minute. The ice was delivered automatically into dump cars and finally dumped on the river bank. So far as tried the ice hoist has worked successfully, but the winter has been a mild one and there was little opportunity to use the machine. It is believed, however, that the

SHOWING TYPICAL ICE CONDITIONS IN THE WET-WELL OF ST. LOUIS WATER INTAKE SYSTEM AND BUCKET ELEVATOR FOR REMOVING ICE IN OPERATION.

Printed as insert to Municipal and County Engineering, Chicago, Ill., August, 1920.

ice hoist will be a decided gain to the Department in keeping our pumps supplied with water in the severest weather."

1904.

"An unprecedented amount of trouble was experienced at the wet-well on account of ice coming through the tunnel during the extreme cold weather. The ice elevator at the south end of the wet-well broke down at the beginning of the cold weather and could not be repaired owing to the impossibility of emptying the wet-well at the time. Two derricks with hoisting engines were placed at opposite ends of the wet-well and were kept running continuously as long as ice came in. These engines were used altogether 26 days, hoisting 500 to 600 cu. yds. of ice per day. The expense amounted to about $5,000.

"Plans are being made for building a new elevator at the north end of the wet-well and also for repairing the old one at the south end, so no further trouble may be anticipated from that source.

"Pipe and sewer connections for washing away the ice have been made."

1910.

"The unusually long and severe winter materially increased the cost of keeping the gates at the intake tower free from ice, this item amounting to $1,256.46. The early gorging of the ice below Chester, extending up as far as Sawyers Bend, eventually raised the stage of the water temporarily obviating all difficulties, but rapidly-moving ice packs following the breaking of the gorge and the resulting fall in river level so damaged the timber boom as to render it unfit for further service. At the later lower stages the ice closely hugged the east face of the tower, not being warded off by the boom, partially blocked the drawing gates and compelled the opening of the unscreened emergency gate, thereby admitting large lumps to the tunnel and increasing the quantity to be handled by the conveyors in the wet-well. The cutting of an opening in the southwest corner of the tower at an elevation as low as the present emergency gate with the continuation of a necessary dike or breakwater west of the tower, extending from bed rock to elevation 85, at which stage there is little trouble, for purpose of diverting ice floes away from the tower would, in connection with the boom on the east side, as has been the practice, tend to minimize any further trouble. The cutting of the east bank of the river above the tower has changed the direction of the current slightly, so that where it formerly was parallel to the tower it now strikes the east face at a slight angle. This has in some measure, at least, increased the quality of ice to be handled at any stage."

1911.

"The timber of the old boom built in 1900 and which has been in service since, were so badly decayed as to need replacement throughout.

"An ice deflector, made up of 12x12 in. timber faced with ¼ in. steel extending from elevation 90 to river bed and projecting out into the stream 5 ft., was securely fastened to the east face of the tower, north of the north gates, at a cost of $934.81. The year gave no opportunity for a test of its efficiency, ice troubles of low river stages being prevented by other means."

1912.

"The most serious situation the Department has faced in years was caused by an accumulation of slush ice and frazil in the wet-well following a break-down of the two ice machines Sunday evening, December 21. Beginning next morning, derricks were ready to handle the ice and the north conveyor repaired and run for a few days until it broke again, but it was not until ten days later that the well was cleared of ice. The cost was $16,600; $9,820 of which was for labor alone.

"The deflector placed on the east side of the tower last year proved unsatisfactory at the higher stages of water. It is proposed to replace it with a boom and to supply timber curtain of varying depth for use as a further safe guard."

1913.

"Practically no troubles were experienced from ice this year. The stage of the river when ice was floating was such that the boom and a floating curtain constructed

VIEW OF OLD INTAKE TOWER OF ST. LOUIS WATER WORKS SHOWING ICE CONDITIONS AND TIMBER FLOATING BOOM FOR FENDING OFF ICE FROM ENTERING SUPPLY TUNNEL.

by the tower-keeper deflected most of it away from the gates and only a little needle and slush ice came to the gratings over the gate ports."

1916.

"With both towers in operation ice troubles were minimized, there being more than 1 ft. of slush ice in the well only during one period of 4 days."

1917.

"Ice troubles during the winter have been minimized by low river stages, but between Dec. 13 and Feb. 21 a force of from 3 to 4 men at the new tower and from 4 to 8 men at the old tower have been on duty at all times."

The unusual cold winter beginning Dec. 8, 1918, and continuing until March 1, necessitated keeping a force of men at the towers and in the wet-well the greater part of the time to prevent the ice from shutting off the supply of water. Six men were kept at No. 1 tower and two men at No. 2 tower. In the wet-well the number of men varied from none to twenty. At times the two bucket ice hoisting machines in the wet-well were unable to remove the ice as fast as it came in, and on Feb. 21 and 22 ice collected to a depth of 16 ft. all over the well, this serious condition lasting for a period of twelve hours.

The cost of removing the ice from the wet-well during the winter of 1917-18 was $1,418.07, exclusive of the cost of power, water used in washing the ice into the river and the engineman's wages.

Steam Introduced in 1918

In 1918 plans were made to introduce steam into the new tunnel in the uptake shaft on the river bank a distance of 560 ft. from the wet-well in such quantities as may be necessary to raise the temperature of the water in the tunnel a small fraction of a degree, enough to prevent the formation of ice. The plant was installed in the fall of 1918. When operating the steam will be run direct from the boilers through a 4-in. pipe to the uptake shaft and delivered into the tunnel, where it will have a distance of 560 ft. to travel and mix with the supercooled water before reaching the wet-well.

Further study of ice troubles were made during the winter of 1918-19 at the new tower when large quantities of ice were carried into the tunnel (the gate on the west side being open) in the form of slush and needle ice. The temperature of the water at this time was found to be 32.2 degrees Fahrenheit. The current was not parallel to the faces of the tower but struck it on the west side at an angle of about 10 degrees. Immediate relief was obtained by opening the gates on the east side and closing those on the west. This operation was performed several times to verify the conclusion that masses of floating ice, on striking the tower, were broken up and the clinging frazil and slush ice was carried by the suction of the water into the tunnel through gates 15 ft. or more below the surface. It will be very difficult, if not impossible, to prevent large quantities of ice being carried into the tunnel at the new tower when fields of floating ice strike it. The advantage gained by increasing the velocity of the current by contracting the channel with the hurdle dikes is, in this respect, lessened.

Production of Frazil Ice

Ice troubles always follow a sudden fall in temperature, approaching zero or lower, in the upper river valleys, when the river is not frozen over at the towers. There are five conditions favorable to the production of frazil ice which is the chief cause of our ice troubles, namely, low temperature, clear water, open river, strong wind and snow or sleet; these conditions produce supercooling of the water to a fraction of a degree; the water entering the tunnel is under increased pressure of nearly two atmospheres which prevents any formation of ice and the consequent rise in temperature which would otherwise occur, due to the increased agitations; but on reaching the wet-well the agitation continues and the pressure is reduced, causing the frazil ice to form and the temperature to rise to the freezing point.

No advancement in the art, or science, of separating ice sediment and water has been made since 1901, when the timber boom was constructed to fend off the floating ice and the bucket elevators were installed to remove the ice collected in the wet-well.

The problem is difficult because of sediment carried by the current. If the velocity of the water was checked at the tower the ice would come to the surface, but the sediment would fall to the bottom, forming a barrier to water entering the ports which might be harder to overcome than the removal of the ice would be.

An ordinance appropriating money to reconstruct Homer's Dike, raising it to Elevation 83 became effective in May, 1920, and a letting was held June 22, 1920, for doing the work. When this dike is reconstructed the water above the dike will flow by the old tower from which the supply will be drawn and in severe weather that portion of the river freezes over and the water flowing beneath will be free from frazil ice. At the present time the water flows over the low portion of the dike and the supply for the old tower is drawn from the channel of the river, which is laden with ice in extreme cold weather.

The new intake tower presents a more difficult problem, owing to the greater depth of water and a swifter current there.

Various ways have been suggested but a satisfactory solution of the ice troubles has not been found.

Satisfactory Solution of Problem Not Yet Found

The introduction of steam into the tunnel to melt the frazil ice has been successful as far as carried, but the amount of steam used never exceeded 10,000 lbs. per hour, which is less than one-half the amount required to melt the quantity of ice which came into the wet-well during ice troubles in 1918, estimated at 2,200 lbs. per minute, and raise the temperature of 160,000,000 gals. of water per day one-tenth of one degree Fahr. The B. T. U. required for this work is 24,700,000 per hour, requiring the burning of 40 to 45 tons of coal per day.

As an emergency measure, melting the ice is satisfactory but for economical operation a better solution is sought.

NOVEL AND ECONOMICAL MIXING DEVICES FOR APPLYING CHEMICAL COAGULANT TO WATER RECOMMENDED AFTER TESTS AT MILWAUKEE

By Joseph W. Ellms, Consulting Engineer, Cleveland, Ohio.

(Editor's Note:—After conducting extensive experiments on the purification of the water supply of Milwaukee, Wis., Mr. Ellms recommended the construction of a rapid sand filtration plant of a capacity of at least 160 million gallons per day, to purify the raw water supply drawn from Lake Michigan. He recommends chlorination of the filtered water. He recommends, also, that in designing the filter plant advantage be taken of certain information gained in the experimental work, namely, that adequate mixing of coagulating chemical solutions with the water may be obtained in comparatively simple devices of much less cost than those now commonly employed. The following matter is from Mr. Ellms' report and pertains to the novel and economical mixing devices for applying the chemical coagulant, upon which he conducted experiments, and which he recommends.)

A feature of rapid sand filter plant design which has some times received little or no attention, and at others improper treatment, is the manner in which the chemicals are applied to the water to be coagulated. It is believed that the correct method can only be developed when there is a proper understanding of the chemical reactions in-

volved, and of the physical phenomena which follow these reactions.

As all chemical reactions of the type utilized in coagulating water are extremely rapid, their velocity increasing with increasing temperature, it merely becomes a matter of bringing together as quickly as possible the reacting compounds. Since the volume of the chemical solution (or solid where dry feeding is used,) is very small as compared with the volume of water to be treated, it is apparent, that in practice it becomes a mechanical problem of bringing the reacting substances together.

The device which has been widely used to effect this mixing, more especially where softening the water is the object sought, is what is known as a mixing chamber. These chambers usually consist of a series of long, narrow channels, sometimes baffled vertically, and sometimes not baffled, but practically depending upon the velocity and length of travel of the water to effect the mixing action.

The experimental mixing chamber used in this investigation is described herewith, as are also the other devices used to produce rapid and thorough mixing. These other devices are all believed to be more or less novel, and departures from existing practice. That they are simpler, and very much less expensive to construct, is obvious. How well they did the work for which they were designed is shown.

Four Types of Mixing Devices Tested

Four different types of apparatus for mixing the coagulating chemical solutions and the raw water were installed. They are described in detail as follows:

Mixing Channels or Chamber.—A mixing chamber provided with baffles of "around the end" type, occupied nearly the whole of one side of the building. It was 60 ft. by 11 ft. and 9 ins. in plan, and contained 22 channels. The channels were each 60 ft. long and had a cross-sectional area of approximately 13 ins. in depth by 5½ ins. in width. The channels were arranged in steps with a total drop from the highest to the lowest channel of 2 ft. and 5 ins.

Fish Ladder.—In this apparatus a compact mixing device was produced by placing short "around the end" baffles in a narrow but rather tall vertical tank. The height of the tank was 7 ft. and its dimensions in plan 1 ft. by 3 ft. It contained 17 baffles placed 4 ins. apart. The passing space around the end of the horizontal baffle was 4 ins. by 1 ft. in area. A distance of 6 ft. existed between the level of the water entering the device and the usual level in the settling basin.

Fall.—A simple mixing device of another type designated as the "fall" consisted merely of a wooden box 4 ft. by 4 ft., in plan, and 3 ft. deep. Near the top and extending the whole width of one side was a receiving tray approximately 10 ins. by 10 ins. in cross section. The water was discharged into this tray, together with the coagulant solution, and spilled over the side to an apron set at an angle of about 45 degrees and which had two 1-in. high riffle strips extending across the whole width of the apron. The water fell from the apron on a pile of stones in order to still further agitate the flow.

Flume.—A further elaboration of the idea embodied in the "fall" was produced by the construction of a riffled flume. This mixing device consisted of a trough or flume 28 ft. long, 2 ft. wide and 1 ft. deep. It contained 13 riffles 6 ins. high and set 2 ft. apart throughout the length of the flume. The flume was set at an angle so that the water had a drop of about 4 ft.

TABLE I.—SHOWING VELOCITY AND LOSS OF HEAD IN FLOW OF WATER THROUGH VARIOUS MIXING DEVICES

Name of Device	Rate of Pumpage in Gallons per Day	Number of Feet of Travel	Time of Travel Mins.	Time of Travel Secs.	Velocity in Feet per Sec.	Loss of Head in Feet
Mixing Chamber.....	125,000	1320	18	45	1.17	2.41
Mixing Chamber.....	125,000	720	10	22	1.16	1.38
Mixing Chamber.....	250,000	720	8	40	1.39	1.58
Mixing Chamber.....	250,000	360	4	5	1.48	0.79
Mixing Chamber Mod..	250,000	109	1	10	1.56	0.69
Mixing Chamber Mod..	250,000	218	2	23	1.52	1.38
Fall.....	250,000	3.9	0	10	0.39	2.30
Fish Ladder.....	250,000	59.5	0	45	1.32	2.60
Flume.....	250,000	27.3	1	15	0.36	4.00
Flume—Fall.....	250,000	18.6	0	50	0.37	3.00
Flume—Jump.....	250,000	12.0	0	1.3	9.00	1.75

Remarks—In original mixing Chamber each of the 22 channels was 60 feet long. When modified each channel was 18.9 feet long.

Results

Table I shows the velocity with which the water moved through these various devices for different rates of pumpage. Measurements of velocity were made with floats, and also by means of a salt solution. The losses of head are approximately correct in most cases. Most of these losses are well within that which good design would permit, but some of them are doubtless too high.

The poorest mixing action was obtained with the "fall"; some improvement was effected after changes were made in the manner of introducing the chemical solution, but on the whole its action was rather unsatisfactory. Somewhat better results were obtained with the "fish ladder," but as this device is in reality an "around the end" baffled mixing chamber placed vertically, it offers no particular advantage except in taking up but little space.

It was observed when using the mixing chamber that prompt coagulation, which is, of course, an indication of the completeness of the mixing, took place in the first 5 or 6 channels, but that the size of the floc had decreased as the water passed through the lower channels. In some cases the flocculation did not make its appearance until 7 or 8 channels had been passed, reaching its best condition in the 10th and 12th channels. The long travel, however, appeared unnecessary and even harmful in breaking up the floc.

In order to see whether reduction in the size of the flocculated particles was due merely to the velocity acquired in the straight channels, or was caused by the agitation of the water as it reversed its direction of flow at the ends of the channels, the latter were blocked about 18.9 ft. from the end and new openings cut through the baffle walls. The same number of reversals of the direction of flow was obtained, but the length of travel in each channel was cut down from 60 ft. to 18.9 ft.

The results were as satisfactory as those previously obtained, but no more so, although nearly 70 per cent. of the chamber had been cut out of service.

The "flume" as originally designed, consisted of an inclined trough provided with low weirs placed 2 ft. apart. The water in flowing down the flume formed a series of cascades. An excellent mixing action was produced at a comparatively low velocity of flow. The loss of head, however, was too great. By cutting the "flume" into two parts and attaching the box known as the "fall," the loss of head was cut down about 25 per cent. The results obtained were good and were secured with a low

rate of flow. The device takes up little room as compared with a mixing chamber.

In the last device an entirely new principal was utilized. By removing the weirs from the "flume," extending it slightly into the receiving box ("fall"), and placing a low weir at the end, there was produced by the rapid flow of the water down the "flume" a "hydraulic jump." By the impact of the water flowing down the "flume" into the pool back of the weir, a turbulent condition of the water was produced, which effectively mixed the chemical solutions and the water. The chemical solutions were applied at the head of the "flume." The water acquired a velocity of 9 ft. a second in flowing down the "flume," but this velocity was practically all dissipated in complex eddies, at the "jump." Considerable air is trapped in the "jump," and its escape contributes materially to the turbulent condition of the water and consequently improves the mixing action.

The results with this device have been very satisfactory, and the reason for it requires explanation. When a precipitate is the product of a chemical reaction, it first appears in a very finely divided condition. In the case of a colloidal precipitate such as ferric hydroxide or aluminum hydroxide (the two compounds utilized in water purification,) the aggregation of these particles into larger masses is necessary, not only to entrap the fine sediment and minute bacteria in the water, but to prevent them from passing through the sand bed of the filters. It is obvious that violent and continued agitation of the water will hinder rather than assist in this clotting together of these particles, and hence, to aid this coagulation, a quiescent condition is necessary.

The "hydraulic jump" mixing device provides an extremely rapid and thorough mechanical mixing of the chemical solution and the water to be treated, thereby bringing the reacting substances together and hastening the reaction. Immediately following the "jump" the water flows quietly to a settling basin in which the physican action of coagulation can take place with the least possible amount of agitation and thereby reduces to a minimum the breaking up of the floc during its formation.

The proper mixing of the chemicals with the water, and the chemical and physical conditions resulting have been discussed in some detail because of its importance in the design of a plant. By the adoption of a simpler design a great deal of money may be saved in the construction costs.

Another factor in the problem of properly coagulating a water of as low average temperature as that of the Milwaukee water supply, has also been given considerable attention. The low temperatures undoubtedly do retard coagulation, and it has even been claimed that for this reason the water supplied to Milwaukee could not be properly prepared for filtration. While the floc formed in the coagulated water has at all times been quite small, it has never failed to produce the requisite thickness of colloidal mat on the surface of the sand of the filters.

So far as effective mixing, and proper coagulation are concerned, the experiments have proven conclusively, that devices can be designed which will effectively handle the water supply of the city, and that their cost of construction will be much less than some of those now commonly employed.

THE ECONOMY RESULTING FROM THE USE OF VARIABLE SPEED INDUCTION MOTORS FOR DRIVING CENTRIFUGAL PUMPS

By Prof. Melvin L. Enger and Mr. William J. Putnam, College of Engineering, University of Illinois, Urbana, Ill.

The centrifugal pump is inherently a variable speed machine. Fig. 1 shows the relations between quantity, head and speed in the case of a typical centrifugal pump. An examination of the figure will show that when any two of the three variables are selected the third is determined. For example, if the speed and quantity are chosen the head is determined. With the usual arrangement of an induction motor direct-connected to a centrifugal pump the speed is fixed. The speed of an induction motor is not quite constant, but decreases with increasing loads, affecting the relation of the head and quantity delivered by the pump somewhat as indicated

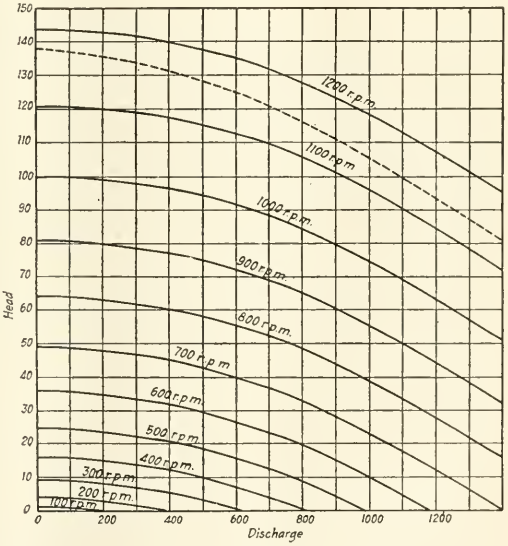


FIG. 1—RELATIONS OF SPEED, DISCHARGE AND HEAD WITH A TYPICAL CENTRIFUGAL PUMP.

by the dotted line in Fig. 1. The variation in speed is so small, however, that the induction motor is usually considered to be a constant speed machine.

Four Conditions Under Which Pumps Operate.

There are four general conditions under which pumps operate: (1) Constant discharge against a constant head; (2) constant discharge against a variable head; (3) variable discharge against a constant head, and (4) variable discharge against a variable head. The first condition is the ideal one for centrifugal pumps, driven by constant speed motors. Pumps delivering water to filter plants or to surface condensers often fall into the second class. The third condition is probably a rare one. In the fourth class would be included pumps used in water

works plants for delivering water into distribution systems, because in this case variations of the water level in reservoirs and elevated tanks cause the head to vary, while variations in demand cause the quantity delivered by the pump to vary. In the last three cases it is customary to select motor-driven centrifugal pumps, operating at constant speed, which will operate satisfactorily under the most adverse conditions, and to control the head and discharge by valves at all other times.

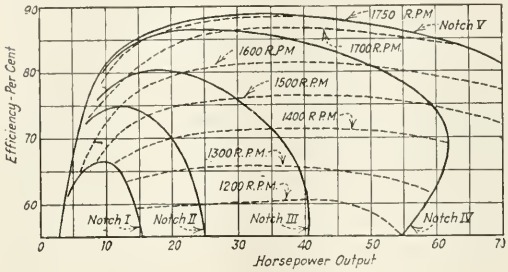


FIG. 2—CURVES SHOWING RELATIONS OF HORSEPOWER OUTPUT EFFICIENCY AND SPEED OF A WESTINGHOUSE 50 H.P., 440 VOLT, 60 CYCLE, 2 PHASE, VARIABLE SPEED INDUCTION MOTOR.

The variable speed induction motor has a wound rotor with its terminals connected to slip rings so that resistances may be introduced into the rotor circuit to change the speed. The action is somewhat analogous to slipping a clutch to secure lower speeds, and is, of course, wasteful. In the Standard Handbook for Electrical Engineers it is stated concerning the variable speed induction motor:

"For any one value of the resistance the speed changes greatly with variations of load and rises practically to synchronous value at no load, whatever the resistance. The higher the resistance the more the speed will vary for a small change in load. An amount of power proportional to the speed reduction is lost in the resistance, that is, if the speed is decreased to 30 per cent. below normal, 30 per cent. of the energy taken from the line is lost."

Fig. 2 shows the relations between horsepower output, efficiency and speed of a 50-horsepower Westinghouse variable speed induction motor used for driving a De-Laval three-stage centrifugal pump in the Hydraulic Laboratory of the University of Illinois. The results of the test of this motor bear out the statements quoted above.

When the head developed by the pump is in excess of the head required under the given condition of speed and discharge, the excess head is usually wasted through a partly closed valve. The power input to the pump remains unchanged because the pump continues to deliver the given quantity of water against the same head no matter how much the valve is throttled. The power used in producing the excess head is wasted. If, however, the speed of the pump is reduced to the proper amount it will not be necessary to waste head through a valve. The head developed by a centrifugal pump varies as the square of the speed when the discharge is zero, and varies approximately as the square of the speed for any discharge within the usual range of operation. If the speed is reduced to 90 per cent. of the original speed the head will be reduced to about 81 per cent of the original head. If this change of speed is accomplished by means of a variable speed induction motor, the efficiency of the motor will be reduced to 90 per cent. of the original efficiency. The efficiency of the pump usually does not change materially within such a range of operation. If the head be reduced to 81 per cent. of the original head by throttling a valve the over-all efficiency will be reduced to 81 per cent. of the original over-all efficiency. That is, the use of the variable speed motor to decrease the head to 81 per cent. of the original value reduces the over-all efficiency by 10 per cent., as compared with a reduction of 19 per cent. in case a valve is throttled.

Example of Saving Effected.

In the case of a motor-driven pump having an over-all efficiency of 55 per cent., delivering 1,000 gals. per minute against a maximum head of 100 ft., but operating against a head of 90 ft. half of the time, a saving of about $150 a year would be effected by the use of a variable speed induction motor instead of a squirrel cage motor, it being assumed that power costs 2 cts per kw. hour. Approximately the same annual saving would be effected by the use of a variable speed motor with a pump of the above capacity and efficiency for any maximum head, provided that the pump operates half of the time at a head 10 ft. less than the maximum.

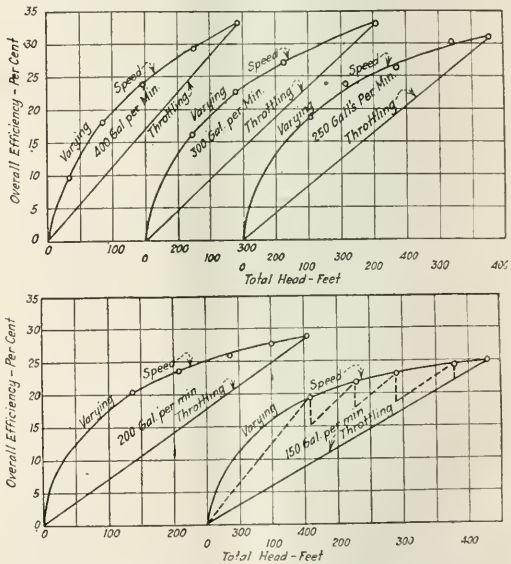
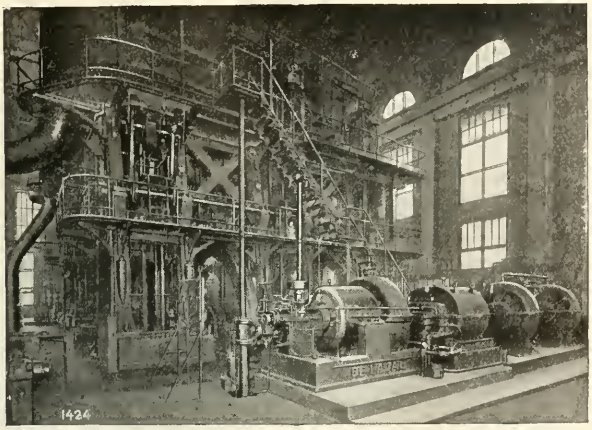


FIG. 3—TESTS SHOWING RELATIVE OVER-ALL EFFICIENCIES OF A MOTOR-DRIVEN THREE STAGE CENTRIFUGAL PUMP FOR VARIOUS HEADS AND DISCHARGES WHEN THE SPEED IS VARIED AND PUMP RUN AT NORMAL SPEED WITH DISCHARGE THROTTLED.

Fig. 3 gives the results of tests on a DeLaval three-stage centrifugal pump direct-connected to a Westinghouse variable speed induction motor. The over-all efficiency of the unit when delivering various quantities



Less Overhead on De Laval Geared Turbine-driven Centrifugal Pumps

THE above photograph of the De Laval unit installed in the Turkey Creek pumping station of Kansas City, Mo., designed to pump 20,000,000 gal. per day against 370 ft. head, shows quite plainly why reciprocating pumps were out of the running. The triple-expansion unit to be seen immediately in the rear of the turbine also has a capacity of 20,000,000 gal. per day against 370 ft. head.

It is obvious that the cost of the centrifugal unit was many times less. It occupies less floor space, weighs much less, requires less expensive foundations and does not extend nearly so far below and above the floor. A high building is not needed to house it nor a heavy crane to overhaul it and it does not require that the building be heavy and substantial.

The casing covers of the turbine, gear and pump are light and easily handled, and upon removal give access to all internal working parts.

While the reciprocating unit has numerous valves, packings and steam valve gears, calling for constant attention for upkeep and adjustment, the turbine-driven pump is simple and requires little attention.

On the reciprocating unit there are innumerable points, including steam cylinders, requiring independent lnbrication. The bearings and gears of the centrifugal unit are lubricated automatically, the same oil being used over and over.

The duty of the reciprocating unit falls off rapidly due to slippage. The duty of the turbine-driven unit is high because of its ability to utilize high superheat and vacuum, and is maintained in service.

To sum up, the De Laval turbine-driven centrifugal pump handles water at the lowest cost.

Our new Pump catalog, W-41, tells of recent developments and extensions in pumping equipment. A copy will be sent upon request.

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of water against various heads is shown when the speed of the unit is varied and also when the unit is run at normal speed and the heads are obtained by throttling the discharge valve. It will be noted that the saving in power effected by the use of the variable speed motor is large when considerable reductions of head are required. The motor driving the pump was arranged for only five running speeds. The smooth curves drawn through the points indicate the over-all efficiency if the resistances introduced into the rotor circuit could be made any desired amount. For the unit used in the tests it is necessary to throttle the discharge valve to obtain heads between those given by the five running speeds. The over-all efficiency for different heads is, therefore, as indicated by the dotted lines in the tests with the discharge of 150 gals. per minute.

In the selection of a variable speed motor to drive a centrifugal pump great care should be taken that the several speed changes shall all be within the range required to produce the specified range of head, and the more speeds within this range the better. The electrical manufacturing companies might well turn their attention to developing an external resistance having a large number of steps.

The resistances consist of cast-iron grids compactly arranged, and are connected with the motor through a controller of the type used on street cars. Considerable heat is developed in the grids when the motor is operated at the lower speeds. The grids should, therefore, be located where the heat generated will not be objectionable. Unless the operator is instructed concerning the advantages of the use of variable speed he is likely to conclude from the heat developed in the grids that it is better to throttle the discharge by means of a valve, because the energy loss in this case is not so apparent, although it is in general about twice as great.

The variable speed induction motor is more expensive than the ordinary squirrel cage motor, but the saving in power resulting from its use, when the head varies considerably, will much more than pay the interest and depreciation on the additional investment.

The foregoing paper by Messrs. Enger and Putnam was presented at the 1920 annual meeting of the Illinois Section of the American Water Works Association.

DEVELOPING HIGH OVERLOAD CAPACITIES WITH HORIZONTALLY BAFFLED BOILERS.

Modern industrial boiler plant practice at present shows a marked tendency toward the use of larger and more efficient units in order to avoid the labor troubles, shut-downs, and standby losses experienced with low capacity and uneconomical equipment. In some instances, this is achieved by rebuilding the boiler house, installing up-to-date high duty boilers, and by introducing the proper machinery for handling coal, ashes and feed water.

In one of the largest textile mills of the country, for example, five 950 H. P. horizontally baffled water tube boilers and superheaters set with underfeed stokers have been installed, to replace 17 250 H. P. and 4 275 H. P., a total of 21 fire-tube boilers equipped with hand fired grates. The water-tube boilers have been in operation for about two years under conditions of unusually severe and continuous service and have fully demonstrated, through satisfactory performance the advantages of units of this size and type. Whereas 10 firemen, 5 water tenders, 2 repair men and 1 foreman were required formerly, the present force consists only of two men, one to watch the boilers and the other to operate a coal crane.

The present article describes briefly a series of four tests conducted on one unit of the installation to ascertain whether an arrangement of the horizontal baffling

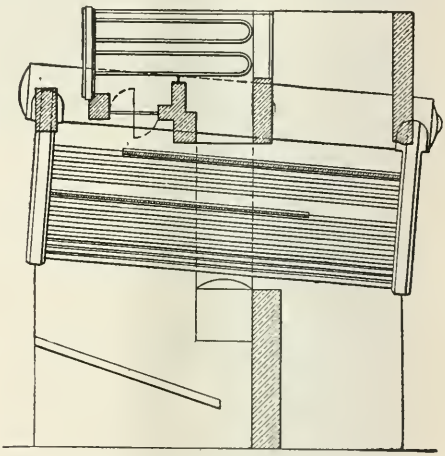

FIG. 1. 950 H. P. HEINE THREE-DRUM WATER TUBE BOILER EQUIPPED WITH SUPERHEATER.

suitable for attaining high capacities would prejudice the efficiencies obtainable at lower ratings.

The tests were run under the usual working conditions prevailing in the plant in order to get results which would represent the commercial performance to be expected in industrial service from large stoker-fired boilers of this type. Nothing was "polished up" in order to get record-breaking results. At the time of the trial, the boiler tested had been in continuous service for 3½ months.

All of the plant load, in excess of the capacity developed by the unit under test, was handled by three of the other boilers operated at moderate rating by the regular boiler room force.

The fuel burned was taken at random from the large tonnage in storage at the plant and comprising many deliveries from various sources. The results of analysis indicated that this was only a fair grade of low-volatile Pennsylvania coal, typical in quality of the vast quantities of similar fuel delivered to the New England mills during the past two years.

The boiler tested was a standard Heine horizontally baffled boiler set as shown in Fig. 1. The arrangement of baffling should be particularly noted. It is simple and inexpensive to repair, replace or to change in location. Such modifications are often advisable if high efficiency is to be maintained with different furnace conditions re-

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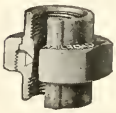

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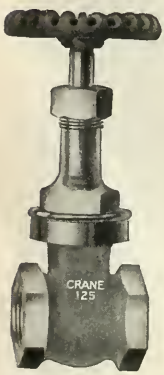

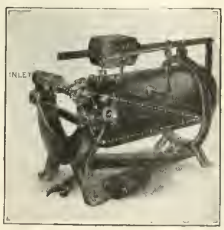

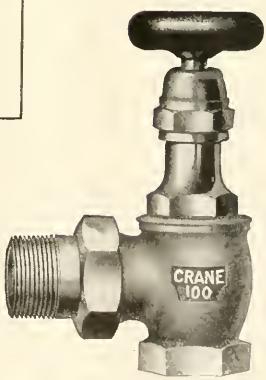

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sulting from a change of fuel or operation. The principal dimensions of the boiler are as follows:

No. of steam drums.....3
Diameter of steam drums.....42 ins.
Length of steam drums.....20 ft. 9 ins.
No. of tubes.....551
Diameter of tubes.....3.5 ins.
Length of tubes.....18 ft.
Water heating surface.....9500 sq. ft.
Superheating surface.....633 sq. ft.
Grate surface including dump grate....147.4 sq. ft.
Ratio of water heating surface to grate surface.....64.5 to 1
No. of Riley stoker retorts.....10

A thorough examination of the boiler, superheater, setting and stoker was made before and after the tests were run. The boiler was found to be free of all leakage, and deposits of soot or slag on the heating surfaces. There was some scale in the tubes which increased in thickness from nothing in the upper tubes to 1-16 in. in the lower ones. The brickwork of the furnace, setting and superheater was in good condition. The baffling was intact and tight. The Riley Stoker was in excellent mechanical condition throughout the tests.

The method of conducting the boiler trials was that prescribed by the A. S. M. E. Code. All instruments and scales were compared with standards. The calibration of the water measuring tanks was checked by independent observors.

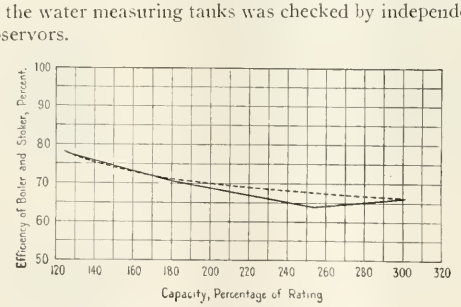

FIG. 2. EFFICIENCY CHARACTERISTIC OF BOILER AND STOKER.

The coal was weighed by a sealed scale carrying an overhead hopper of 2,000 lbs. capacity, from which it was transferred as required through a chute to the stoker hopper. The scale was provided with a self-registering beam. Duplicate tickets were made at each weighing. The coal analyses, Table 1, were made from carefully worked down samples of 500 lbs. taken from the crushed coal during each test. All stoker siftings and samples were weighed back. The ash analyses, Table II, were made on samples representing the entire quantity of refuse as weighed down in the usual manner. At this point it may be well to direct attention to Tables I and III, and to the discrepancy in the percentages of moisture in the coal for Tests 1, 3 and 4. The values given in Table III, with the exception of that for Test No. 2, are correct for coal as fired. They were determined by drying representative samples of coal during the tests. No determination of moisture content was made during Test No. 2, but the analyzed percentage was accepted

TABLE II.—ASH ANALYSIS

	Sample 1		Sample 2	
	As received	Dry Basis	As received	Dry Basis
Weight all through ¾-in. screen	1.7 lbs.		2.0 lbs.	
Weight over 2 mesh screen	0.3 lbs.		0.4 lbs.	
Weight over 4-mesh screen	0.5 lbs.		0.9 lbs.	
Moisture	14.94		18.67	
Combustible	12.86	15.11	13.52	16.63
Earthy matter	72.20	84.89	67.81	83.37
	100.00	100.00	100.00	100.00

TABLE III.—SUMMARY OF DATA AND RESULTS

	Test 1 Sept. 30, Oct.,'19 24 hrs.	Test 2 Oct. 3-4,'19 21 hrs.	Test 3 Oct. 7,'19 3 hrs.	Test 4 Oct. 10,'19 3 hrs.
Steam pressure, gauge	134.0	130.0	140.0	141.2
Superheat, degrees	136.2	126.4	99.2	153.5
Feed temperature, degrees	127	127	125.5	129
Flue temperature, degrees	541	600	670.8	694
Pressure in wind box, inches	2.63	4.3	6.2	6.46
Draft in Uptake, ins.	.293	.75	1.18	1.25
Total coal fired	42,605	124,569	28,561	32,270
Per cent. moisture in coal	2.89	1.61	2.33	2.56
Total water fed	825,605	1,032,301	209,391	243,208
Factor of evaporation	1.208	1.204	1.192	1.217
Coal fired per hour	3,867	5,931	9,520	10,757
Coal fired per retort per hour	386.7	593.1	952.0	1075.7
Dry coal per sq. ft. of grate surface, per hour	25.47	39.6	63.1	71.1
Water evap. per hour	34,400	49,157	69,797	81,069
Equivalent evap. per hour	41,555	59,185	83,198	98,661
Builders rated, horse power	950	950	950	950
Boiler horse power developed	1,250	1,716	2,411	2,858
Per cent. rating, developed	126.8	180.6	253.8	300.8
Water evap. per lb. coal as fired	8.89	8.29	7.33	7.54
Equiv. evap. per lb. dry coal	11.07	10.14	8.95	9.41
B. T. U. per lb. dry coal	13,850	13,917	13,581	13,796
Per cent. ash, dry coal	10.91	10.54	12.23	11.19
Per cent. combustible in ash	15.11	16.63	.....	.....
Combined efficiency	77.56	70.71	63.93	66.21

TABLE I.—COAL ANALYSIS

	Sample 1		Sample 2		Sample 3		Sample 4	
	As received	Dry Basis	As received	Dry Basis	As received	Dry Basis	As received	Dry Basis
Weight all through 2-mesh screen	1.6 lbs.		1.4 lbs.		*1.8 lbs.		1.7 lbs.	
Weight over 4-mesh screen	0.3 lbs.		0.2 lbs.		0.3 lbs.		0.2 lbs.	
Moisture	2.20		1.61		1.53		2.29	
Volatile matter	21.82	22.31	20.68	21.01	20.15	20.46	20.70	21.19
Fixed carbon	65.31	66.78	67.34	68.45	66.28	67.31	66.08	67.62
Ash	10.67	10.91	10.37	10.54	12.04	12.23	10.93	11.19
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Sulphur Separately determined	1.88	1.92	2.23	2.27	2.19	2.22	2.44	2.50
B. T. U., per pound	13545	13850	13692	13917	13373	13581	13480	13796

* All through ¾-in. screen.

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as correct. The samples collected for analyses, (Table 1) dried somewhat during the working down process. If a sample for Test No. 2 had been dried out, it probably would have shown a slightly higher moisture content than 1.61 per cent. This greater value would have increased the efficiency for Test No. 2, and raised it into line with the values for Tests Nos. 1 and 4, as shown by the dotted curve of Fig. 2.

Feed water was measured in three carefully calibrated tanks holding an aggregate of 9128 lbs. of water at 130°F. The test boiler was provided with an independent feed pump and piping. Hot and cold water were available at the measuring tanks enabling the close maintenance of the feed water temperature.

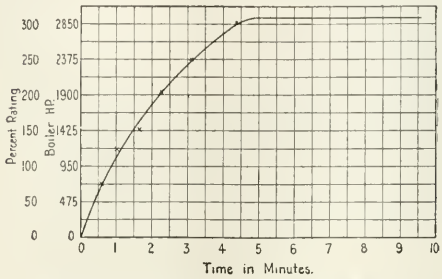

FIG. 3. CURVE SHOWING EXCESS TEMPERATURE OF GASES FROM STEAM BOILER AS AFFECTED BY RATE OF DRIVING.

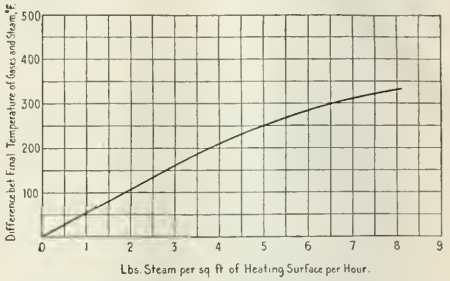
Difference bet. Final Temperature of Gases and Steam °F.
500
400
300
200
100
0 1 2 3 4 5 6 7 8 9
Lbs. Steam per sq ft of Heating Surface per Hour.

FIG. 4. CURVE SHOWING HOW RAPIDLY THE HEINE BOILER WILL TAKE UP A HEAVY OVERLOAD STARTING FROM A BANKED FIRE.

Every percaution was taken in the feed and blow-off piping to insure the measurement of all water entering the boiler and to guard against any leakage.

The coal consumed and water evaporated were determined for each hour of the test to obtain the approximate rating developed. The rating was also observed by means of a General Electric indicating flow meter.

Readings of pressure, temperature, draft, etc., were taken at 15 minute intervals. Analyses were made for CO2, CO and O2 in the furnace flue gases.

Fires were cleaned one hour prior to starting all tests. Especial care was exercised to duplicate the conditions of the fuel bed at the beginning and end of all trials.

Tubes were blown every six hours during the 24 hour test.

The complete data for each test are given in Table III. In judging the performance results obtained, several important factors should be considered. The coal burned was not a high grade selected fuel but had a fairly high ash content and produced a troublesome clinker at high rates of combustion. The results as obtained with this fuel should therefore be considered as most creditable. The uniformity of the test conditions was materially affected by the variable operation of the three other boilers in service, all supplying steam to a common system. The limitation of capacity performance was entirely due to the inability of the stoker to handle and dispose of the troublesome clinker produced.

The data show that high overload capacities can be developed with this type of boiler and arrangement of baffles. The efficiency characteristic of the boiler and stoker is drawn in Fig. 2. The point corresponding to Test No. 3 is open to question, because the coal used contained more ash than the coal of the other tests. Since the resulting clinker interfered noticeably with the management of the fire at the high rating obtained, this may well account for the low efficiency of Test No. 3. The dotted curve probably represents the true characteristic of the boiler when burning coal of the quality used as long as it can be worked through the stoker. If the efficiency of Test No. 2 were raised slightly by alteration of the moisture content, as mentioned previously, it would agree closely with the dotted curve. The excess temperature of the gases from the boiler as affected by the rate of driving is given in Fig. 3. Fig. 4, shows that the boiler starting from a banked fire can take up a 300 per cent. overload in 4 minutes 23 seconds. From the excellent performance of this boiler at high overloads—overloads which were limited only by the fusing of the clinker in the low and fair grades of the coal used—it would appear advisable to consider the desirability of using larger grate areas than is customary.

The results further establish that the arrangement of baffling which is especially suitable for obtaining maximum capacities does not affect adversely the efficiencies obtained at lower ratings. High overloads could have been readily maintained for indefinite periods if a higher grade fuel had been available.

The combustion results obtained were consistently good. The flue gas temperatures were not extreme considering the capacities developed. The condition of the heating surfaces after tests was found to be good with little accumulations of soot and with no deposits of slag.

CHLORINE MAKES BETTER SHOWING THAN OZONE AT MILWAUKEE.

Since ozone as a disinfecting agent for public water supplies has been used in Europe in a considerable number of municipal plants, some of which are of fair size, Mr. Joseph W. Ellms, Consulting Engineer, Cleveland, Ohio, in his experiments on the purification of the water supply of Milwaukee, Wis., decided to try the use of ozone as a disinfecting agent, and to make such necessary studies of its value and adaptability to Milwaukee conditions as time would permit.

It should be stated that the Milwaukee water supply has been chlorinated for some years and "the value of this process to Milwaukee has been very great when

measured by the reduction its use effected in deaths from intestinal diseases. It still remains the only barrier between consumers and epidemics of typhoid fever and other water borne diseases." Quoting further from Mr. Ellms' report, we have his recommendations on disinfection to follow the recommended filtration:

"That disinfection of the water after being filtered be practiced as a second line of defense against contamination; that chlorine be used for this purpose, and that the amount applied be approximately one-half that which was used on an average in treating the raw water supply of the City during 1919.

"That no attempt be made at the present time to employ ozone as a disinfecting agent for either the raw or filtered water, since the experimental evidence obtained indicated the apparatus had not been developed sufficiently to produce ozone at low enough cost to enable it to compete with chlorine as a disinfecting agent, and that the first cost of installation and the subsequent cost of operation and maintenance would be too high for use in a large municipal plant of the size required by Milwaukee."

PLANNING MOST SUCCESSFUL MUNICIPAL CONVENTION

The American Society for Municipal Improvements will hold its annual convention in St. Louis on October 11-15 of this year. This choice was made at the request of the St. Louis members, who were very anxious to secure this meeting, and who are making elaborate plans to entertain the convention. Recently a meeting of engineers, contractors, and others interested in municipal development was held, and six committees, involving a total membership of about forty, were formed. These were Committees on General Arrangements, on Finance, on Exhibits, on Entertainments, on Badges, and on Automobiles. The General Committee consists of Mr. S. Sammelman, Chairman, Messrs. E. R. Kinsey, C. M. Talbert, Nelson Cunliff, Harland Bartholomew, Edward E. Wall, Arthur L. O'Leary, Wm. Stoecker, W. E. Ferguson and W. W. Horner. The Society is represented by W. W. Horner, Vice-president, resident of St. Louis, and by Mr. C. C. Brown, Secretary, who made a special trip to St. Louis recently to attend a meeting of the committee.

Mayor Henry W. Kiel of St. Louis has sent out a general call to mayors and municipal officials all over the country to attend this meeting, and it is expected that special conferences will be arranged between mayors of cities of the same class. Mr. E. R. Kinsey, president of the Board of Public Service, has sent a similar invitation to a mailing list of over three thousand engineers.

St. Louis men are making a particular effort to make this the most successful meeting of municipal officials and engineers ever held. They feel a proprietary interest in the American Society for Municipal Improvements because of the presidency of the society having been held by a St. Louis man, Michael J. Murphy, for the first two years of the society's existence. It is also felt that the meeting in St. Louis is very apropos because of the large variety of municipal enterprises now under way in that city.

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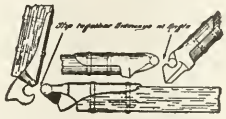

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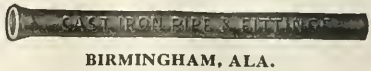

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Construction News and Equipment

DRAGLINE EXCAVATOR USED ECONOMICALLY IN BUILDING HIGHWAYS IN THE PLATTE VALLEY IN NEBRASKA

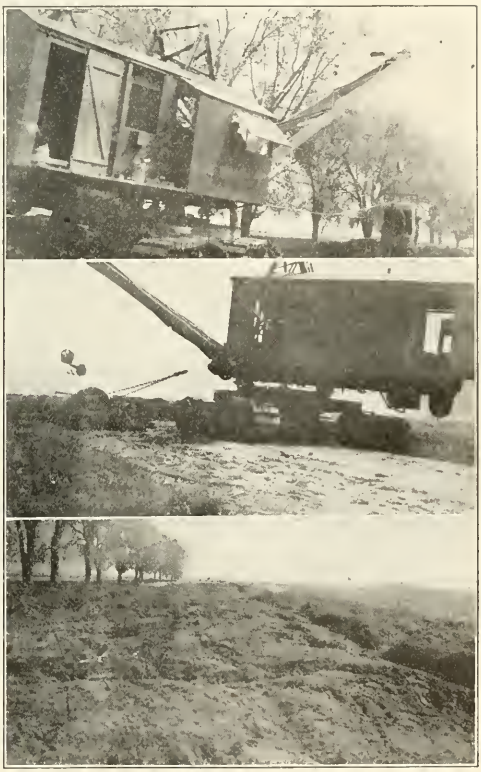
By George E. Johnson, Secretary, Nebraska Department of Public Works, State House, Lincoln, Neb.

One of the most interesting Federal and State Aid road projects now under construction in the State of Nebraska, is known as No. 27, and is located in Merrick and Nance Counties, and runs from Central city to Belgrade. The road is located in a particularly low and flat country, as it starts within three miles of the Platte River. At three times during the construction season this year, the road has been completely under water, so that from the standpoint of safety and economy, it was necessary to provide a road which would be in a good condition for travel the year around. In order to have such a road, it was found, after the preliminary survey, that the road would have to be raised from 2 to 3 ft. above the surrounding country. At the beginning of the season, the road was in fairly good condition for travel, though somewhat rough; especially was this true of the last two miles, near the end of the project. The soil is very sandy. Silver Creek crosses the road about 3½ miles north of the beginning of the road, and in order to build the road across Silver Creek bottom, which is very low and flat in contour, ditches were excavated on either side, and the material excavated was used to make the fill, and thereby raise the road to the necessary height.

Instead of using the usual elevator grader to make the cut, and the ten or more teams to haul the material, a drag-line excavator, with a capacity of 1 yd. was purchased. At the present time the work is being done by a force consisting of a Superintendent and four men, two of whom operate the machine.

It can readily be seen that the saving of labor is no small item due to the method of handling the work. A project of this size generally calls for from 10 to 15 men, and equally as many teams, if not more. With the present method, the force is reduced considerably and no hauling is necessary. The advantages of the method of building a road of such a type, may be considered from an economical and time-saving standpoint. First, the contractor will experience few days of lost labor expenses, because of waiting for the low places on the road to dry up sufficiently after a rain. The excavating machine can work irrespective of weather conditions. Second, all material within the right-of-way can be utilized for fill, notwithstanding the obstructions such as telephones, etc., which are often found in the way. With two men operating the machine, 500 cu. yds. of earth can be excavated with an uninterrupted run of ten hours. Third, the work is taken out to exact sections, called for by the plans; however the fills contain excess materials.

It is naturally to be expected that it will take some time for the fills to compact, and there will be considerable finishing necessary before a good compact roadway will result. But, in spite of the drawbacks, the method has merit. Constructing earth roads is proving very successful and economical by this method, and will solve the problem that has bothered many State Highway Departments for some time, and it will be especially useful in building roads in the Platte Valley, where the finished grade must be raised from 2 to 3 ft. higher than the surrounding country. The conditions have been such that heretofore, it has been impossible to borrow dirt with an elevating grader to any great depth on the side of the road.



P. & H. DRAGLINE EXCAVATOR USED ON ROAD GRADING IN NEBRASKA.

View of the 1 cu. yd. Dragline Excavator used in Road Building in Platte River Valley, where it is impossible to borrow dirt with an Elevating Grader—Another View of the Dragline. Water lies along the Roadsides which are very flat and low—Rough Fills made by Dragline must stand for Many Days before they are Finished and Shaped.

Printed as insert to Municipal and County Engineering, Chicago, Ill., August, 1920.

NEW RECORD MADE ON CONCRETE ROAD CONSTRUCTION NEAR PARIS, ILL.

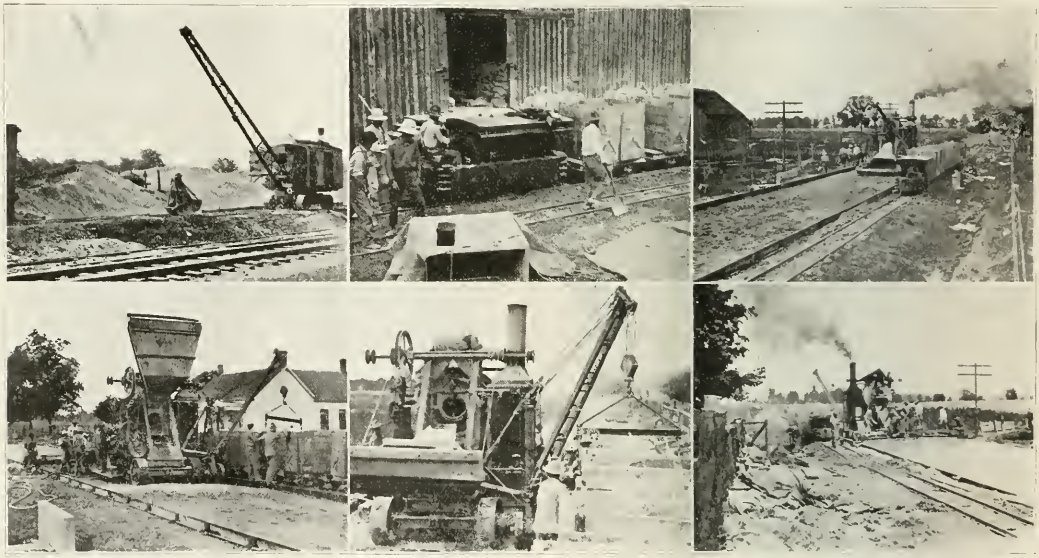
A new world's record was established by Alan Jay Parrish, the prominent Illinois Highway Contractor, on June 30, 1920, when, with a 21-E Smith Simplex Paving Mixer, he laid 744 lin. ft. of concrete road, 16 feet wide, 8 inches thick, on a million and a half dollar contract near Paris, Ill.

This remarkable run was made in 9½ hours, using a four bag batch and allowing a full minute mix on each batch. The average time, throughout the entire day, for mixing and placing each batch, was just 75 seconds. The complete cycle of mixing operation ran from 70 to 72 seconds. Considering the fact that a full minute of mixing was required, this allowed 10 to 12 seconds for the loading and placing operation—the speediest average yet recorded on a complete day's run.

Action of the Paving Mixer

The factors contributing to this new record are worthy of study. The action of the paving mixer, as the principal factor, was primarily responsible for this accomplishment, although many other conditions contributed to the good work. The operations of the paver have been so synchronized that the discharging time and the skip-raising time were perfectly balanced. When the operator pulled the discharge lever, he would also engage the skip-raising lever. Thus the drum was completely emptied by the time the loaded skip, fully raised, began to reload the drum for the next mix. This perfect synchronism of operation, together with the brainy co-ordination of the supply crew, made it possible to maintain this record-breaking speed. No time was wasted. A second after the mixed batch was discharged, the material for the next batch was sliding into the drum of the paver.

In loading the skip with the aggregate from the "turn-over" batch boxes, the time agreement in the movements of the skip and the derrick helped materially in avoiding unnecessary loss of any time. The movements of the derrick with which this paver is equipped are controlled by the movements of the skip. The derrick cable works over a drum on the skip-hoisting so that, as the loaded skip is raised, the derrick-hooks lower. When the skip is completely raised, the derrick-hooks are fastened to the loaded batch box, then as the skip lowers, the derrick cable rises, lifting the loaded batch box to just the proper height by the time the skip has reached the ground. Two men swing the batch box into position and dump its contents into the skip. Then the skip is raised and the derrick- hooks lower away the empty batch box to its car on the industrial train. During the minute of mixing, there is ample time to spot the batch box cars in position for the derrick to grab the next loaded box.



CONSTRUCTION EQUIPMENT USED ON CONCRETE ROAD CONSTRUCTION NEAR PARIS, ILL., WHERE A NEW RECORD HAS RECENTLY BEEN MADE

To appreciate fully how this 744 foot record was made, it is well to study other details of the job besides that part played by the paver itself. Starting with the arrangement of the material yards, everything was carefully arranged for speed.

The Industrial Railway

The yards are located at Oliver, Illinois, slightly more than a mile from the road Mr. Parrish is constructing. The sand and stone are unloaded from the cars by a ½ yard, full revolving Erie Crane, operating on a track parallel to the unloading siding. The crane deposits the material in huge material piles alongside the 24 in. industrial railway loading track. The same crane is used for filling the storage bins which make possible the speedy measuring and loading of accurate amounts of sand and stone for each batch box.

The industrial cars, each with two batch boxes, start at

744 Feet in One Day!

16 Foot, 8 Inch Road Paved by Smith Simplex Paving Mixer

This is the World's Record

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the loading bins, where the proper proportions of sand and stone are loaded. A hump has been built in the track at the loading bins so that the train then moves by gravity to the cement loading platform, where the cement is added to each batch box. Plymouth 3-ton locomotives then haul the trains to the paver. There is no back-switching after the trains once start through the loading process; they travel continuously toward the job. That helps eliminate waste of time.

Each locomotive handles 10 cars, carrying 20 batches. At no time during the day was there any delay in waiting for the next train to pull into position. A train was always ready on the siding. During the 9½ hours that the paver ran, 22 train loads, carrying 440 batches, were used. The mixture was a four bag batch of 1-2-3½ proportion.

An important detail that was handled in a particularly careful manner was the method in which Mr. Parrish prepared the grade for his industrial railway system. He has found from experience that a carelessly formed grade may eventually cause expensive trouble through derailments and delays. So this grade was built up properly and thoroughly drained before any steel was placed upon it. The result has been worth while; in laying over a mile and a half, so far, on this contract, he has had only two minor derailments.

The placing of the railway sidings was carefully planned so that it would be always possible to have the train load of batch boxes at the paver just when the material was needed. This eliminated the danger of the paver having to stand idle while awaiting the aggregate.

After completing a mile and a half of the pavement, the paver was moved back to the starting point and reversed, to work in the opposite direction. This reduced the length of the haul from the original loading station. Ordinarily this change would necessitate the shifting of the industrial car track to the opposite side of the road, within reach of the derrick. Due to the fact, however, that the derrick with which this paver was equipped is interchangeable to either side of the paver, the track was left on the same side of the road. The only change required was to move the derrick to the other side of the paver.

Heltzel Forms and Parrish Tamping Machine

The latest model of Heltzel Steel Forms were used and the tamping and finishing was handled in a very efficient manner by the new Parrish Tamping Machine.

Organization of Crew

It is particularly interesting to find that in breaking all records with this 744 lineal footage, a new low record was also probably established in the cost of the entire work. Although the exact figures are not available, it is a fact that the economies effected by the various labor saving devices were remarkable. To accomplish this big job with only 32 men, including every man on the job, from superintendent down to the water-boy, is a real achievement. The crew consisted of the following:

2 Crane men.
4 Men loading batch boxes—stone, sand and cement.
4 Train men.
8 Grading crew men.
2 Men ahead of Paver, handling batch boxes.
1 Engineer.
1 Fireman.
3 Men spreading concrete behind machine.
1 Tamping machine operator.
2 Men spading and edging.
1 Superintendent.
2 Foremen.
1 Waterboy.

Total number in crew, 32 men.

SANITATION OF ROAD CONSTRUCTION CAMPS

By John N. Edy, Chief Engineer, State Highway Commission of Montana, Helena, Mont.

This subject will be discussed very briefly and from the standpoint of the relatively small camp such as might be maintained by the average road contractor operating in the state.

As I view the subject it quite logically subdivides into two principal divisions: First, Camp Accommodations and, second, Camp Regulations. In other words a camp is maintained in a sanitary state by providing the necessary accommodations and by enforcing regulations designed to keep it so. Here, as in so many others of life's relationships, there is the opportunity for the mutal advantage of close and sincere co-operation between the parties most interested.

Camp Accommodations

It seems hardly necessary to detail those camp accommodations that make for the safe and healthy habitation of men engaged in useful work. That the camp is usually but a temporary domicile does not in the least lessen the

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Grading Roads. Where road beds are low and need "shouldering up," or where fill must be made through water-logged and swampy land, the P & H Excavator-Crane will pull in and heap up the ground much faster and cheaper than will teams and graders.

Making Cuts. The P & H will make cuts in roads at the rate of 300 to 500 yards per day. The average cost seldom exceeds $20.00 for a day's operation. When the excavated material is loaded in wagons, the capacity is reduced only about 10 per cent. For constructing drainage ditches the P & H is run alongside or center of the completed road, excavating the ditches to the required depth and wasting the dirt on the slope of the road bed or beyond the ditch. On this operation the machine cost is rarely over 8 cents per yard, even when handling wet earth where it is often impossible to work teams.

Excavating Gravel. Capacity (approximate) 300 to 500 yards per day of gravel from the bank into trucks and wagons. The hauling equipment, working with a P & H, is never in the excavated hole as it is with steam shovel or trap loading. The P & H Excavator-Crane has a full circle, non-obstructed swing with an operating radius of 30 feet.

A Complete Portable Locomotive Crane. Equipped with a hook, magnet or other grappling device, the P & H is a complete portable locomotive crane with a lifting capacity of 3,500 pounds at 30-foot radius. Great for cleaning up a yard, placing pipe in trenches, pulling piles, moving the bulky stuff, loading and unloading cars. Remember the P & H has a full circle swing and is entirely self-contained, ready to operate on any spot without propping or stabilizing of any kind; worth its cost for this ability alone.

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necessity and desirability for the application of the recognized principles of sanitation; it does, however, intensify the problem in that the plan of sanitation must be reasonably inexpensive as well as sufficiently effective. Considering this phase of the subject hurriedly we may assume that in a comfortable and sanitary camp there must be:

1. Good wholesome food.
2. Palatable and safe drinking water.
3. Clean and comfortable sleeping, dining and lounging quarters.
4. Prompt and continuous disposal of kitchen wastes.
5. Adequate and comfortable toilet facilities, including bath accommodation.
6. Proper segregation of all stables and out buildings.
7. Reasonable fire protection.
8. First Aid Service.

Other desirable features might be suggested, but these seem to represent or include practically all the essentials.

Fundamentally, men who work must eat. And if they are to work well and usefully they must eat substantial, well cooked food, served in a clean appetizing manner. This means a careful selection of foods; a thoughtful composition of menus and the most careful preparation and appetizing service of the meal by competent persons of cleanly habits and appearance. It means that during summer months the kitchen and dining room (or tents) must be screened because flies must be excluded: (I prefer the exclusion of flies to entrapping them on fly paper on in small pans filled with fly poison. Even if a dead fly is harmless, a sticky mass of dead flies can hardly be said to be "appetizing.") Our first requirement means also that uncooked food will be properly stored, always free from contamination due to any cause whatever, including our two camp enemies, flies and rats. "Good, wholesome food" then, means, in substance, that those persons attached to the camp will be permitted to enjoy their meals as well as to be nourished and sustained by them.

Of course water may be either safe and not palatable, or palatable and not safe—and the latter is not infrequently the case. The water supply would seem to be the most potential source of danger and should be adequately protected from contamination. While perhaps the ordinary mountain stream represents a safe supply, there is no assurance that such is the case. Certainly water from the ordinary irrigation canal should be viewed with suspicion. As a matter of fact it would seem to be but sensible, and the exercise of every-day caution, to have the water examined and tested by a competent person before approving its use. And then, as above suggested, the source of supply should be policed or otherwise insured and safeguarded. Water taken from a creek or river should be procured well up-stream from the main camp, and the immediate vicinity not used for any other purpose. If conditions justify, the water may be boiled or otherwise treated to increase its degree of purity.

But men do not live by food and drink alone. They—and especially is this true of men who do hard manual work—must have restful beds and comfortable lounging and recreation quarters. It is not necessary that a bunk house be "dolled up" like a bridal suite of a metropolitan hotel. It is necessary, however, that the quarters be clean, cheerful, ample in size, well ventilated, well lighted, well heated when necessary, and equipped with clean and comfortable cots, bunks or beds provided with sufficient clean bedding. One would think it altogether unnecessary to refer to this feature of the camp; and yet in this state and in all states are altogether too many examples of the unsanitary, unhealthful and uncomfortable camp sleeping quarters. The bunk house should be cleaned regularly and the bedding aired and washed; in a camp of any size a camp tender should be provided. If screens add to the comfort of the men, they should be provided. And I have in mind one accommodation that is very rarely provided: I refer to the construction of cheap gravel cinder or plank walks that permit the men to pass to and from the several camp units without tracking dirt, mud and filth into the quarters.

All kitchen wastes should be deposited in covered garbage cans and removed and disposed of sufficiently far from the camp area. Cheap incinerators may be provided for burning the refuse, or it may be buried. I have spent some time in and about construction camps, and have never been quite convinced of the necessity or desirability of maintaining a hog ranch as a means of camp garbage disposal. I regard it as unfortunate but it seems to be none the less true that most camp cooks either own or very speedily acquire one or more squealing pigs which they proceed to develop on camp garbage. If a pig sty must go with the camp, it should be located not closer than the adjoining county.

Camp facilities for receiving and disposing of bodily wastes are usually crude and unsanitary when very little additional expense would provide proper and safe accommodations. The danger here is from flies and the contamination of drinking water. A reasonable care and thought in laying out the camp site will permit an arrangement of out buildings that will be both safe and sanitary. Disinfectants should be used freely and frequently and the exterior premises maintained in a neat and clean condition.

Most men desire to bathe but those who are not so inclined should be required to observe the usual rules of bodily cleanliness. Bathing accommodations must be provided and used.

Needless to say, stables and similar units should be properly segregated and cleaned. Stable waste must not be permitted to accumulate, but must be removed regularly.

Reasonable fire protection may be provided in several ways, one of which involves the erection of a modest and inexpensive water tank that may be filled by pumping and with which is a sufficient length of hose to reach the principal units of the camp. Fire protection may not be thought to be an essential of sanitation. But the tank and hose may be used to advantage for laying the dust by sprinkling.

First Aid service is essential; particularly in camps far removed from medical practitioners. In large camps a physician may be retained to make frequent physical examinations of the men, and to advise in matters of general sanitation.

Nothing has been said of laundry facilities, although it would seem that this matter is important and must certainly have the attenion of the camp proprietor.

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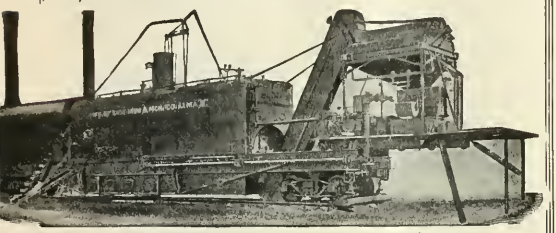

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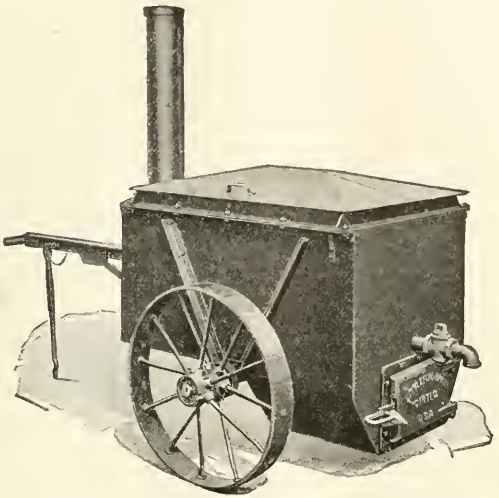

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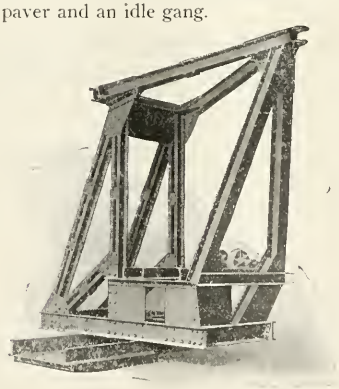
Camp Regulations

And now, briefly, what of the other divisions of the subject, that relating to camp regulations? Simply this: that as long as men are human they will at times become careless. Few men are naturally or habitually unclean; but many men are thoughtless and not a few are ignorant of the most elementary health rules. A camp can be kept sanitary only by the most rigid enforcement of regulations covering the requirements of the case. Typewritten copies of these regulations should be placed conspicuously in every unit of the camp, and as new men enter the camp they should be informed as to the text and significance of the sanitary regulations. Experienced and wise contractors will discharge an employe more readily for violating the camp rules of sanitation and conduct than for failing to perform the manual task assigned him.

The foregoing paper by Mr. Edy was presented at the recent annual convention of the Montana Public Health Association.

SMITH PAVER HAS SCIENTIFIC FRAME

An authority on road construction recently remarked that fully 90% of the paver breakdowns were due directly or indirectly to the frame. The frame is the foundation—if it fails to stand all of the terrific strains imposed upon it, some other vital part will probably drop out of alignment and soon the contractor is tied up with a broken paver and an idle gang.



FRAME OF THE SMITH PAVER

Realizing the great importance of this feature, the engineers in designing the Smith Simplex Paving Mixer have built into it unusual strength. Ordinarily it might not appear as though such great strength is necessary until some important facts in connection with the operation of a paver are considered. On a boom and bucket machine having a capacity of 21 cu. ft. of mixed material, the tension on the rope that supports the boom is 8½ tons. This pull creates a thrust on the boom toward the machine and against the bottom of the frame of over 10 tons. Add to this the strain of a cubic yard of stone, sand and cement being constantly lifted up and thrown down in the revolving drum; the weight of all the necessary machinery, engine, boiler, etc., and it becomes obvious why particular attention should be paid to the construction of the frame.

The frames of the 14-E and 21-E Smith Pavers are made of *double channels* combined into a single pillar of strength by ¼-in. steel gusset plates, all hot riveted. This construction gives a strength 12 times as great as single channels and six times as great as two channels separately. On the 10-E where the stresses are much less, the construction is the same except that angles instead of channels are used.

This studied construction is valuable to the contractor because it gives him added years of service out of his paver, and at present prices this is a feature that the contractor must look for.

CONSTRUCTION PLANT ON IOWA ROAD JOBS

The Floyd county, Iowa, concrete paving project is making rapid progress. The Gravey Weinberg Construction company officials as soon as they were awarded the contract on May 18 went home, packed up their outfits and were on the job laying out their plant and getting ready for actual work almost before the contract signatures were dry on the paper. A train of beer refrigerator cars, put out of business by the "dry" laws, was leased from a Milwaukee brewing concern and put to hauling cement instead of beer. Daily these cars make their trips from Charles City to the cement manufacturing plants at Mason City and came back loaded with road building materials instead of "booze." This company's outfit is going strong; they have laid 550 ft. in 12 hours several times and most of the time are able to put down 50 lineal feet per hour, reports the Iowa Highway Commission Service Bulletin. A central proportioning plant has been established at the Floyd crossing and Ford trucks with Lee bodies holding four bag batches carry the material on an average haul of three miles to the mixer. A second mixer is ready for installing on the job. The contractors plan to have the eight mile section completed by September 1.

Henry Horst, the Illinois contractor, on the five mile stretch at the Clear Lake end of the Mason City-Clear Lake road to the county line is making good progress. He is using a central mixing plant with Ford trucks and Lee bodies hauling a 4-bag batch an average of about two miles. Mr. Horst by a system of bonuses is speeding transportation to the maximum. The truck drivers have entered into the contest with spirit and the race is on to such an extent that the contractor declares he is likely to go broke paying bonuses. So far he has had good success in delivering the wet mixed batch on the job in perfect condition for the placing on the road.

O'Neil & Sons and the Hinkle Construction company, the other Cerro Gordo county contractors, are installing Industrial rail equipment on each of their jobs. The tunnel method of loading has been adopted in which the material is stored in large elevated bins under which the cars are run and the material dumped into them by means of levers.

The Raymond Wright company has started pouring concrete on the Des Moines Ankeny road in Polk county. They are using a centrol proportioning plant stationed at the county farm and hauling the mixed materials in trucks, equipped with Lee bodies. A portion of these trucks carry two of the Lee bodies each with its batch of material doubling the transportation value of the truck.

EDITORIALS

WANTED: SOME HORRIBLE EXAMPLES

What can be done to impress upon the public the importance of employing engineers to do engineering work? Much has been done and still more can be done through engineering journals which are read to some slight degree by non-technical city officials. Also, by furnishing engineers with specific examples showing the folly of entrusting engineering work to the uninformed it is likely the engineers will be able, in some cases, to safeguard their interests. But this is all insufficient. The people must be reached directly. How shall it be done? Our answer is: through the popular magazines.

We are glad to have among our acquaintances a clever man who has for years made a specialty of writing popular articles on engineering subjects. And he has been very successful in getting his articles printed in the popular magazines of large circulation. We suggested that he prepare articles on: An Engineer for an Engineering Job, and offer them for publication in popular magazines. He has consented to undertake the work.

What direction shall the presentations take? Argument, unless concealed, is distasteful. This generation argued itself down to a whisper before and during the war. Preachments are also out of date; the populace is, for the time being, fed up on preaching of all kinds, if we mistake not. The appeal must be elemental. As the average patriot is interested only in being warm, dry (outside), well-fed and entertained we must pin our hopes to entertainment. We must give him some interesting stories and in reading these he must get the point without suspecting that an effort is being made to instruct him.

Now, in glancing over the popular magazines of the day, it seems to be the prevailing style in composition to alternate anecdote and application. The title may or may not contain an obvious play on words, though this is highly desirable for purposes of regularity, but it is absolutely essential that the article begin with an interesting anecdote. Follow with a short application, not so long as to bore the reader or to arouse his suspicion that an effort is being made to tell him something, and then swing easily into another simple narrative, follow with the application, etc., etc.

We have undertaken to furnish some horrible examples of the employment of the unfit and we ask the co-operation of our readers. Undoubtedly every engineer has at least one anecdote to tell. Let us have it and we shall pass it on to the popular writer who will not mention names and places, as it is not the object of this work to hold any individual up to ridicule or to reflect discredit on any locality, but to drive home some truths of general interest, ignorance of which is making trouble for taxpayers and is costing them good money.

THE TIME ELEMENT IN ENGINEERING LITERATURE

The time element, unfortunately, often operates to curtail the production of engineering literature and also to reduce its usefulness. More often than not when engineers are asked by editors or society secretaries for a professional paper on a project in hand the invitation is declined because of lack of time. Sometimes engineers are too busy to write, and this fact is fully appreciated, but we are convinced from years of editorial experience that where too much is not attempted the preparation of a useful engineering article is a simple and pleasant task. Some articles require a long time in preparation but articles of that type are not in the majority. Such articles are those involving theoretical discussion, necessitating much study, and those in which there are elaborate compilations of data. But the great majority of engineering articles relate to specific projects. It should be as easy for the engineer in charge of a project to describe it as to recount the events in his life. To him it is a simple story, easily told, if he does not insist on making hard work of it.

Perhaps the most useful type of article at this time is the one describing the construction methods and equipment employed on a job. To the engineer in charge this is, or should be, easy. If he will but outline the salient features of the work on the back of a calling card and then call in his stenographer and dictate the story as it comes quickly to his mind, the composition is soon roughed out. Running the pencil over the typed statement straightens out the structure of the composition and the job is finished. Prompt publication is easily secured and the profession has a bit of current experience for its guidance. This is every bit as easy as it sounds. The dictated article is likely to be most useful, not at all because it is dictated but because it comes from a man who probably wouldn't find, or take, time to write in any other way. It is obvious that the most helpful articles are the ones from men who are doing things. They may be too busy to write out in longhand an elaborate article, but they are not too busy to dictate a short one. Engineering literature needs the dictated, short article. It is well to point out that in dictating the features that come to mind are the

important ones, of greatest general interest, while trivialities of local interest do not come readily to mind and are not included.

The old way to write an article on a specific project was to wait until after the job was finished before beginning. Then the history of the project was recorded in detail, including the legal and financial disorders of its infancy, but omitting the very points that troubled the engineer from day to day. Invariably these are the points of interest to other engineers and are the ones most likely to be included in a dictated article. We hope engineers will agree that the dictated, short article on the projects of which they have charge are easily possible and well worth while.

ALDERMAN ADVISES ENGINEERS TO MAINTAIN LOBBY

A Chicago alderman recently addressed the Chicago Chapter of the American Association of Engineers and offered some practical advice with respect to the influence of politics on engineers. In substance, he advised the engineers to get into the game, not only in self-defense, but as a public service. While there are many fine engineers in the service of the city of Chicago, there are some men in charge of minor engineering work who are not engineers at all and got their city positions solely because of their political usefulness, according to the alderman.

After pointing out that many engineering projects are headed by men who know nothing of engineering work, the alderman said: "That is where you ought to start your work; start lobbying and stop this sort of thing, not only in the city hall, but in the county building and down State. Have your men on the job, your so-called 'lobbyists,' and let them get busy. See if you can't succeed in passing a law in the legislature making it mandatory on the Governor, the mayor, the president of the county board, to appoint engineers. Do this so we won't have to go and pick up real engineers on the outside in our dealings with the public utilities, spending the taxpayers' money twice when it need only be spent once. When the State legislature is in session you should have a man down there watching every move pertaining to engineering. When your man is through there he should come to the city hall, covering the city hall as regards engineering. It should be done."

The alderman offered to introduce a suitable ordinance in the city council in line with his suggestions.

The word "lobby" may frighten many high-minded engineers because of its use, for many years, as an opprobrious epithet. But it describes an established system which is often exercised for the public good. Few measures are put through legislative bodies of any grade without being pushed, hauled and driven through by an interested, energetic lobby.

THE GRAY WOLF DIED POOR

A certain man grew old in the service of his city. He served as a prominent member of the city council for a period as long as the span of the average life. He was a man of courage and of positive convictions and made strong friends and bitter enemies. His party politics did not agree with that of the powerful newspapers of his city. They opposed him habitually. They called him a "gray wolf" and created the impression among the people, who depend for their information entirely upon the newspapers, that he profited greatly in deals with private interests at the expense of the city. It was held that he systematically prostituted his office for his own gain. Many people considered this man wealthy. They loathed him for his unclean money.

When he died it was established in the probate court that his estate amounted to only seven thousand dollars, in these days a small estate for even an honest man to leave. And this modest estate consisted of a four thousand dollar equity in a small home, which he was paying for in installments, and the balance consisted of house furnishings, and other necessary personal property, and a pitifully small sum of money in bank. And so the truth came out. He wasn't a "gray wolf" at all; just a poor, old man who lived and died in the service of his city.

And what did the newspapers say? They did not entirely suppress the news of his penury; it was told in a few lines of type inserted near the bottom of a page near the middle of the paper. While he lived, front page columns and seven column heads were used to tell of his alleged dishonesty. These were read and are probably remembered. Only careful readers would note the short and simple evidence of his honesty published after his death.

The newspapers, as assassins of character, are the greatest enemies of good government, whether municipal, state or federal. They use language for the concealment of thought, to becloud all issues, to muddy the sources of information. Until we have clean newspapers we must expect that many men will decline public service. A great lawyer once said: "Serve the corporations well and they will pay you well; serve the people well and they will crucify you." How often has the truth of that statement been demonstrated! As long as the newspapers defame our public men and are believed by the people we can scarcely expect good government. The wonder is that public officials will serve at all.

There is less of the milk of human kindness in the treatment of public officials today, by newspapers of the political opposition, than was contained in the sponge of vinegar held up to the cross almost two thousand years ago.

Novel Construction Methods Employed on Morris-Ottawa, Illinois Concrete Road

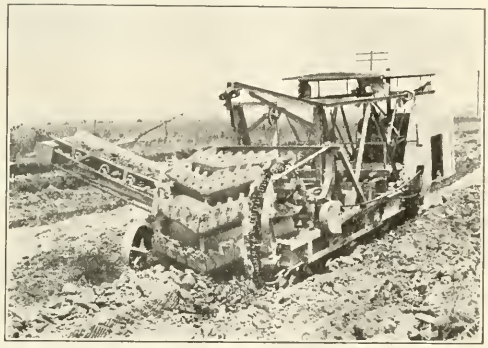
By J. E. Huber, District Engineer, Illinois Division of Highways, New Clifton Hotel Building, Ottawa, Ill.

The construction of the Federal Aid Road between Morris and Ottawa, Illinois, which is a part of the Chicago-St. Louis road, has brought out some novel construction methods. The R. F. Conway Company of Chicago has the contract, consisting of 21 miles of Portland cement concrete pavement 18 ft. in width. Directly west of Morris for a distance of eight miles the road passes through gently rolling country but for the remaining distance the route follows the north bluff of the Illinois River Valley overlooking both the river and the Illinois-Michigan Canal. When completed this will be one of the most beautiful drives on the proposed system of improved highways in Illinois.

The old road along the bluff was very narrow and winding and its improvement required considerable heavy grading in widening and re-locating portions of the road to eliminate dangerous turns. Along quite a distance a special road section is being used which provides a curb along the up-hill side and an earth shoulder 8 to 10 ft. wide on the opposite side, instead of the standard section which provides a 6-ft. earth shoulder and ditch on both sides of the pavement. Special attention has been given to the design of the culverts and bridges at the numerous ravines crossing the road, in the way of providing drop boxes and inlets to collect the water falling upon the road surface.

Specially Constructed Excavator

The heavy excavation is being done with a specially constructed machine designed by the contractor. The accompanying illustration shows the principal features of the machine, its operation being quite similar to that of an elevating grader, though it cuts for a width of 5 ft. 6 ins. to a maximum depth of 18 ins. It is equipped with



VIEW OF SPECIALLY CONSTRUCTED EXCAVATOR USED IN GRADING FOR MORRIS-OTTAWA (ILL.) CONCRETE ROAD.

VIEWS SHOWING LIGHT TRUCKS DUMPING MIXED CONCRETE ON SUB-GRADE OF MORRIS-OTTAWA ROAD. FINISHING MACHINE AND SIDE FORMS ALSO SHOWN.

VIEWS OF CENTRAL CONCRETE MIXING PLANT ON MORRIS-OTTAWA (ILL.) CONCRETE ROAD JOB SHOWING LIGHT TRUCKS EQUIPPED WITH END-DUMP STEEL BODIES BEING LOADED DIRECT FROM KOEHRING MIXERS.

a caterpillar traction and its power is furnished by a large gas engine. This machine handles macadam and compacted gravel easily and under favorable conditions it is reported to have excavated over 4,000 cu. yds. of material in a day.

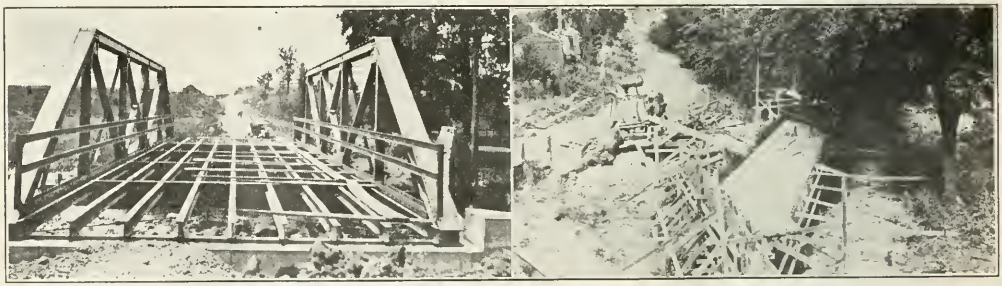
Use of Central Mixing Plants

The concrete for the pavement is mixed at central plants located at convenient railroad sidings, and is delivered on the road by Ford trucks equipped with Lee end-dump steel bodies. At the central plant gravel and sand are unloaded from railroad cars by a locomotive crane and dropped in large piles on a long tunnel about 7 ft. square, constructed of steel and heavy timbers. Trap doors are so located in the roof of the tunnel that a number of industrial cars can be loaded with the correct proportions of sand and gravel. The cars are then pulled by a small industrial locomotive past the cement storage shed and switched to a track which runs close by two large Koehring concrete mixers. The grade of the tracks on which the industrial cars operate is planned so that after the cars discharge their contents into the mixer hoppers they return to the tunnel by gravity, thereby making it possible to operate two trains continuously with one locomotive.

Mixed Concrete Hauled in Trucks

Concrete is discharged from the mixers direct into the trucks, a load consisting of a four sack batch mixed in the proportions of 1—2—3½. The truck bodies are designed so that practically the entire load is carried on the rear axle. The trucks are equipped with large pneumatic tires and are able to maintain a speed of approximately 12 miles per hour when loaded over ordinary earth roads.

When paving work started on this contract the mixed concrete was hauled 4.6 miles yet no difficulty was en-



BRIDGE AND CULVERT CONSTRUCTION VIEWS ON MORRIS-OTTAWA (ILL.) HIGHWAY.
Left: Type of Steel Bridge Used Where Concrete Structures are not Practical. Right: Large Skew Culvert on One of Many Relocations.

VIEWS SHOWING RELOCATION TO ELIMINATE DANGEROUS TURN AND STEEP HILL WHERE ROAD LEAVES A BLUFF ON THE MORRIS-OTTAWA HIGHWAY.

countered in handling the concrete dumped from the trucks onto the subgrade. Concrete mixed fairly dry and plastic is much easier to handle in this way than wet concrete, due to the separation of the mortar and coarse aggregate in wet concrete during the hauling. At first some difficulty was experienced in getting the concrete to dump cleanly out of some of the trucks due to the rough, rusty surfaces of the bodies, but this trouble was quickly overcome by providing these bodies with loose false bottoms of rubberoid roofing material.

After the concrete is dumped on the subgrade it is struck off, tamped and belted with a machine especially built for this purpose which uses the steel side forms for its track. The concrete delivered in this manner is no more difficult to tamp and finish than concrete mixed to the dry consistency required by the Illinois Division of Highways specifications and discharged directly from the mixer on the subgrade, and as this system operates satisfactorily on a haul considerably longer than the average haul on most country road work it is believed the adoption of this scheme will meet with success on a large number of road contracts.

FOUNDATIONS FOR ASPHALTIC PAVEMENTS

By John C. Wilson, Inspector of Pavements, City Hall, Pocatello, Idaho

Conditions resulting from heavy motor-truck traffic are accentuating the necessity of many changes in established construction methods, even so far as to bring under question the sufficiency of the usual type of foundation.

Experiments, tests, and recent articles written in the technical press have directed attention toward the possibility of employing other materials besides Portland cement concrete, and have shown the effect of modern loads in wrecking foundations.

During the war, in the summer of 1918, in Chicago, two weeks of unusually heavy motor traffic upon a perfectly good asphalt pavement smashed the 5-in. Portland cement concrete foundation, with attendant and inevitable injury to the surface.

The question is asked "Why?" and is answered in a few words: "Because Portland cement concrete has no modulus."

The earth or subgrade is the ultimate support of any pavement and Portland cement concrete has a slight advantage over less rigid types of foundation in only one instance, in maintaining an even contour, but is only efficient to its maximum load limit; the relative rigidity of Portland cement concrete gives it a low shock absorbing ability, and pavements not only must support dead-load, but must resist the smashing impact of traffic.

When Portland cement concrete is used as a foundation for bituminous top, this unyielding rigidity causes it to act as an anvil, necessitating the absorption of shock, due to heavy traffic, by the wearing surface, concentrating the full effect of smashing blows on this thin layer.

The last four years have seen an increase in the price of Portland cement which is adding to the usual cost of pavement construction a sum sufficient to give considerable concern; and while public officials may feel they are justified in paying the increased price, nevertheless it might be well to consider whether Portland cement concrete is the proper material for foundation for asphaltic surfaces.

For many years the writer has closely observed the behavior of Portland cement concrete foundations and has come to the conclusion that there are other and more efficient types of foundation that can be constructed at less cost.

Bituminous-Concrete Foundations for Bituminous Surfaces

The use of bituminous-concrete foundations for bituminous surfaces is not a new experiment, in fact, it is very widely employed. Sections laid upwards of 20 and 30 years ago are still giving excellent service in Washington, D. C.; Portland, Ore.; Los Angeles, Visalia, Calif.; Omaha, Neb.; Pittsburgh, Pa.; Denver, Col., and elsewhere. It is the opinion of the writer that study along these lines, particularly in the light of today's conditions, and experiments and tests of the last three years, will disclose that it has many virtues which are lacking in the less yielding Portland cement concrete.

Experience has shown that bituminous wearing surfaces themselves can easily withstand the heavy traffic of the larger cities. Chemical and physical methods of mixture control have developed to a degree that insures the preparation of mixtures capable of successfully withstanding a wide range of climatic and traffic conditions, and it only remains to utilize their virtue in such a way as to obtain their maximum service.

An Asphaltic Base Laid in 1896 Still First Class

I wish to mention one of the early examples of asphaltic concrete base construction in Central California, at Visalia; a pavement laid in 1896 and subjected to continuous mixed traffic of medium intensity. It still is in first-class condition. It originally consisted of a 4-in. base composed of gravel, sand and refined asphalt, all plant-mixed, with a 2-in. wearing surface. Also at San Pedro, Calif., a street leading to Government harbor fortifications, has a pavement composed of 3-in. asphaltic cement base and a 2-in. Warrenite wearing surface. In addition to normal traffic, this street was subjected in 1918 to the hauling of some 30,000 tons of building material for the fortifications, most of which was hauled on 5-ton trucks. Later the 14-in., 60-ton, coast defense guns were hauled over this pavement, which now is in good condition.

The life of a standard asphaltic pavement is seldom limited by the wearing away of its material or by defects inherent in the surface. We have been prone to consider that the only function of a satisfactory foundation for bituminous pavement is to furnish a support for the wearing surface. While it is true that support is essential, it is also true there are many other requirements which should be met, and that aside from the ability rigidly to support loads, Portland cement concrete fails in many ways to supply the conditions which favor the maximum life of a bituminous surface.

Many weaknesses and defects commonly attributed to asphaltic surfaces are the result, directly, or indirectly, of shortcomings of the Portland cement concrete foundation.

If a properly prepared asphaltic wearing surface can be made to hold its shape and is protected from the action of water from below, two of the most common causes of failure will be avoided. This can be solved by an

asphaltic or crushed rock base, properly drained. Thus, it is possible to apply an asphaltic wearing surface to its supporting structure in such a way that the action of these agents are prevented, the most potent forces leading to its destruction are removed, and its average service is greatly increased.

Besides the friction between surfaces in contact, there is no bond between the asphaltic surface and the concrete foundation. Portland cement concrete absorbs moisture from the earth through capillary action. Since a bituminous covering prevents evaporation, the surface of such a foundation is usually moist, providing a condition favorable to disintegration, also destroys the bond which is not integral and due to the effect of traffic shock or thrust produces a horizontal component, and the absence of a positive and integral bond between the wearing surface and foundation becomes, therefore, a source of weakness, and "buckling" results.

Rolled Stone Base

Similarly, there is an abundance of proof, under 5 to 15 years' service in many places, such as Massachusetts, New York, Illinois, Texas, New Mexico, Arizona, Utah, Idaho, Oregon and Washington, that with proper conditions of sub-grade and drainage, compressed stone base (whether old macadam or new construction) affords a superior foundation for stable bituminous surfaces. Such compressed stone base, like asphaltic concrete base, supplies the essential properties of:

(a) Shock absorption.

(b) Unity under compression of base and wearing surface.

With foundation and surfaces, in effect, integral, it is apparent that a most important condition favorable to displacement would not longer exist. Furthermore, it is apparent that a substantial thickness of bituminous concrete will not be so easily affected by temperature changes and will remain cooler in summer and, as a result, more stable under such conditions than will a thin surface.

Also, it may be well at this point to emphasize particularly the effect of the mass and thickness in stabilizing bituminous mixtures. The contact plane between the surface mixture and a rigid Portland cement concrete support, is, as stated before, a seat of weakness. Whether the support is a thin concrete base or the subsoil directly, it becomes important to minimize at this contact plane the intensity of all forces, particularly those tending to lateral movement, which may reach the foundation from the surface. The effect of the thickness of a shock-absorbing medium in distributing and minimizing these forces, should become apparent without further discussion.

NATIONAL CONFERENCE ON ENGINEERING EMPLOYMENT

A national conference on engineering employment sponsored by the American Association of Engineers will be held in Chicago on Nov. 12, 1920. Practically all free employment bureaus will have representatives at this conference. All employment managers of the large industries and employers of technical men will be invited to attend and participate. The object of this conference is to provide a forum for solution of industrial relations problems affecting employers and engineers.

THE UTILIZATION OF MUNICIPAL WASTE

I—The Utilization of Sewage Sludge, with Particular Reference to Experiences at Canton, Ohio.

By William F. Morse, Consulting Sanitary Engineer, 715 Hippodrome Bldg., Cleveland, Ohio

One lesson in economy which was forcefully impressed upon the minds of the people by the war experiences of 1917-1918-1919 is the saving in the minor conditions of household life, meaning the reclamation of substances and articles that heretofore have been thrown away as worthless, that are designated as municipal refuse.

Under the urgent appeals of the federal government for increased conservation in all food products, the transformation of a part of these into substances to be used in war munitions, the reclamation of paper, rags and all matters that could be turned into paper stock, and the general saving of all values known to exist in municipal refuse, there was begun and is being continued a movement in municipal refuse conditions that is now a well defined economic policy for American communities.

Classes of Waste With Recoverable Value

The several classes of municipal waste that have value enough to defray the cost of collection and return some revenue to the towns may thus be stated:

Sewage (Sludge)—In all its forms used for land fertilization.

Garbage—Separately collected, used for stock feeding.

Paper, Rags, Etc.—That can be manufactured into paper stock.

Metals, Glass, Ashes—And other incombustibles.

To these may be added the development of useful heat from the incineration of part or the whole mixed collection. It is proposed to discuss briefly the reclamation of these forms of municipal waste as an economic measure for American municipalities.

Utilization of Sewage Sludge in General

The world has always had in use some form of land fertilization from the excretions of the human body. In the older countries the application is made to the ground directly from the household collection. In modern practice the collected sewage is brought to a point where it is utilized by one or another means or finally disposed of by various forms of treatment.

The economic advantages of sewage farming have long been a debated question. The sight of luxuriant vegetation obtained from land fertilized with sewage, appeals to the imagination and answers the argument that the world requires the return to the soil of matters that can again be used to make the soil more productive. But there are certain limitations that apply in considering sewage fertilization. The area of ground to be treated must correspond to the amount of sewage available in the different forms. The land must be not too far distant from the sewage collection works. There must be steam or electric power for daily use at moderate cost.

When these conditions are duly met and the land is of a character to assimilate and convert the manural properties of the sewage rapidly and without nuisance, then there is no doubt of the economic results. An example of a sewerage installation may be quoted as offering

many advantages for employment of sewage sludge as land fertilizer.

Experiences at Canton, Ohio

In 1914 the City of Canton, Ohio, (population, 1910, 65,000; population now, 80,000) put into service a Sewage Disposal Plant built eight miles south of the city line, comprising an area of about 30 acres along the east bank of the Nimishillen Creek, about ¾ mile long by ½ mile wide.

The works are of the usual type of sedimentation tanks and include screen chambers, grit chambers, six sedimentation tanks of the Imhoff pattern, arranged in two series of three each, sixteen contact filter beds, area ½ acre each, six sludge beds for dewatering sludge, three of these covered with glass for quicker drying, a small pumping plant with steam boiler for general purposes, laboratory building, and equipment for observation record and analysis. There is a brick covering house over the screen and grit chambers with steel stack for ventilation. The boilers, pumps, workshop, are also enclosed in permanent brick building. The plant has a maximum capacity of six million gallons of sewage per day. The present mid-summer flow is 4¼ million gallons.

Early in 1920 the city purchased the farm lands adjoining the sewage treatment plant, comprising about 100 acres of farming ground, including two good dwelling houses, large barn, out buildings, etc., with excellent spring water supply.

The land lies in a half circle around the sewage plant as a center, but on higher ground along the main road. The extreme limits of the ground are about 2,500 feet from the pumping station of the sewage plant.

Up to this time the neighboring farmers have had excellent results from the dried sewage sludge applied to various crops. By employing a "manure spreader," a wagon which has a mechanical attachment for chopping up the sludge and spreading evenly over the ground, the sludge is hauled and spread with a minimum of labor and no initial expense for the fertilizer.

The results of this method are remarkable. A comparison of two fields of equal area sown with wheat at the same time showed an indicated yield of the one fertilized with sludge of upwards of four times the quantity produced by the unfertilized field, and the experience of previous seasons when sludge has been used confirms this estimate by practical returns.

The method of applying the sludge direct to the fields by pumping the liquid from the sludge compartment of the sedimentation tanks through the lines of piping is found to be perfectly practicable. Larger areas of ground can be treated in a shorter time at far less cost and with better results. The permanent line of 2½ in. iron pipe from the pumping station can be run to about the center of the areas lying within a radius of 1,500 to 2,000 feet. This is continued by a line of partly used fire hose shifted as required by one man and controlled by one man at the nozzle. The action of the pump and flow of sewage sludge is noted by a third man. The spraying is greater or less in volume upon particular spots or complete field areas, according to character of soil, contemplated crops or other local conditions. The slight odors from the nozzle are barely noticeable when the stream is flowing and are quickly dissipated by exposure to air and sun.

The practical results of this method of fertilization are readily apparent upon comparing the fertilized areas with those not treated. The crops of hay of this year's growth from fertilized fields were the largest ever known in this county.

The line of separation in the same field of unfertilized area, was distinctly marked, while the yield was barely up to the normal standard of similar unfertilized fields.

So in a similar way the indicated crop of oats from fields with sludge fertilization will be far above the average. The standing fields of corn fertilized with liquid sludge are remarkable in rapid growth of stalk and ear as compared with others unfertilized. When the several crops are harvested and accurately weighed the results of this method of sewage farming will be more definitely known. The intention is for the coming year to divide fields into tracts of equal area, and cultivate these by using different fertilizers. Dried and liquid sewage, sludge, barn yard manure, garbage, and the various forms of commercial fertilizers. This will give definite results for future determination of actual manurial value of sludge in all the various forms.

The Canton sewage disposal works are recognized as being among the most advanced of their class of municipal works. No pains nor expense are spared to keep the operation of the works up to the highest standard. There has just been installed in the building over the screens and grit chambers an incinerator of the most approved type for destroying the sewage screenings, that are removed from the sewage before it passes to the sedimentations tanks. These screenings are a mass of paper pulp, rags, wood, and miscellaneous matters too large to pass the screens, and hold in suspension from 90 to 95 per cent. of moisture. They are worthless for any purpose and very troublesome and difficult to get rid of. There is approximately 125 pounds of screenings from each million gallons of sewage or about 500 to 600 pounds daily. The incinerator is placed beside the screening platform and receives the screenings as they come from the sewage, or if desired there is a small drying surface available for removal of the larger amount of liquids before burning. There is special apparatus for consuming smoke and gases of combustion and the heat is used for maintaining a steady draft in the steel stack of the covering house. This provides for the change of air in the building every few hours and eliminates any odors that might attend the passage of the sewage through the screens and grit chambers.

The operation of the sewage treatment plant has been under the direct charge of Mr. W. E. Sarver, City Engineer, since its construction, with Mr. Frank J. Eversole as Resident Superintendent, and Mr. A. E. Hess as chemist. Mr. H. A. Smith is Director of Public Service.

WHAT IS THE FUTURE OF ENGINEERING?

By Charles Kirby Fox, Consulting Engineer, 435 I. W. Hellman Bldg., Los Angeles, Calif.

Engineering, one of the oldest professions and certainly the most useful, had sunk to such a position that within

the memory of many men now living, to speak of an engineer conveyed the idea of a surveyor, draftsman or possibly a mechanic. Engineers as a class, in spite of the great magnitude of the work which they had planned and successfully carried to completion and its great importance to the world, were ranked behind the other so-called learned professions.

Wait, on page 7 (preface) of his "Law of Operations Preliminary to Construction in Engineering and Architecture" says: "It is not the mere competency to design, draft, lay out, and superintend work that gives reputation to an engineer. This is work done by assistants who are comparatively unknown to the profession. The men who control and direct the work are men of broad ideas and business capacity, whom companies and proprietors expect will look after their business conservatively and hold their investments secure and profitable. This, it is contended, depends largely upon their business and legal training. Without this training graduate engineers find their many technical qualifications without weight in the estimation of their employers, and they feel it keenly when men with a general education are taken, from the ranks of clerk and office help, and are given direction of work as superintendents and managers wholly on account of their knowledge of the business policy which directs the financial operations and because they know from association and study how to decide ordinary questions of business and law."

The realization of the truth of this statement, or some similar earlier one, evidently set some engineers thinking, for it was about this time that engineers really commenced to branch out into such allied commercial lines as contracting, managing and financing, where their technical training was of additional service. Now almost every contracting organization is headed by engineers and many large organizations such as railroads, utilities and cities are managed by engineers and quite a number have gone into financing.

Finally the World's War, virtually an engineer's war, came on and this brought opportunities wherein the engineer measured up so well to the allotted tasks, that engineering took unto itself an entirely new meaning in the public estimation and came very nearly placing an engineer in the White House. This combined with the unusual and rapidly changing state of affairs, brings up the question "What is the Future of Engineering?"

Will engineers continue in their strictly professional work with a strong representation in the related commercial, managing and financing branches, or will they rise to the occasion and take their places as leaders in the various phases of work in which they should rightly lead, such as settling troubles between capital and labor, seeing that fair utility laws are made and enforced, and enforcing a proper influence on the various related legislation which concerns them? In my opinion, there is no class or profession which combines the required training, knowledge, and experience to pass impartially on these great problems as well as do engineers. Their prosperity and welfare depends directly upon the prosperity and well being of capital and labor and upon suitable, fair legislation. Will they continue expanding and developing until engineering will be considered the proper basic training, not only for its numerous branches, but also the various executive and quasi-judicial positions connected therewith?

COMMENTS ON THE "KIRDORTHOFF," OR MODIFIED IMHOFF, TANKS

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, 22 N. Carroll St., Madison, Wis.

Since my article entitled: "Operating Experiences with Imhoff Sewage Tanks," appeared in the March, 1920, issue of Municipal and County Engineering, I have received a number of letters from prominent engineers and editors expressing favorable comment on my modification of the Imhoff tank. For the benefit of those who might be interested in these opinions, I give quotations from them herewith. For convenience of reference, and to indicate that this tank is a combination of the good features of the septic, Dortmund and Imhoff tanks, I have decided to call it the "Kirdorthoff" tank. The word is a coalition of the names "Kirchoffer, Dortmund and Imhoff." The quotations follow:

Chicago, Ill. April 10, 1920.

Your method strikes one at once as so logical and based so completely on good hard sense that the good results you have secured in its application are only what one might expect.

(Signed) Editor of Municipal and County Engineering.

I have read with keen interest the March number of Municipal and County Engineering, containing an abstract of your experience with Imhoff tanks. This is the first time I have seen the paper, and I consider it a very valuable contribution to our knowledge of sewage disposal methods. I am all the more impressed with the value of your contribution, because very early in the exploitation of the Imhoff tank I came to the conclusion that it did not have enough storage space nor was it properly designed for the retention of very fresh sewage, which would inevitably rise, so far as my experience has gone, instead of dropping. I have followed the installation of Imhoff tanks somewhat practicularly, and almost every place where I have heard about them I have found it to be the fact that they did not work well with fresh sewage.

I would point out that reversing the Imhoff tank practically makes a tank such as we have designed at the Great Lakes Training Station and at Madison, Wis., that is to say, the channels separating the tanks, would in my opinion make it more certain that a more decanted liquid would be collected than would be the case with the reversed Imhoff tank.

I have laid your paper away for future reference among a very select list of what I consider to be valuable contributions to the art.

Chicago, Ill., April 6, 1920.

(Signed) John W. Alvord.

We were very much interested in the recent article in Municipal and County Engineering regarding your experiments with Imhoff tank construction. There is an immense amount of gas in American sewage as compared with the German sewage and we have been accustomed to the wasting of valuable greases, and our sewage is of a very dif-

ferent character from that on which Dr. Imhoff experimented.

It is undoubtedly a fact that Imhoff tanks in many instances have been built and used where a great deal of soap and other greases go into the sewage, where there is an immense kitchen waste, quite different from the ordinary municipal sewage. Plants constructed for the Government in connection with cantonments experienced this difficulty. There is a different condition also when the plants are built at a long distance in some remote section, the sewage having become much thinned out by considerable infiltration. All these conditions enter into the question of construction and your experiments undoubtedly are very useful in connection with certain installations.

Possibly Dr. Imhoff would have suggested different measures if he had the time and opportunity to have studied the conditions in this country. Possibly your plan might have been better for Imhoff tanks.

Should we continue to be identified with the Imhoff tanks, we may ask you for the privilege of publishing in the next booklet we issue the article which you have written regarding your experiments or possibly something later along these lines.

We have no way of telling at the present time whether we will be associated in any way with the future handling of the Imhoff patents. We are very much interested, however, in any kind of an experiment along these lines and your design appealed to us as a possible way to overcome foaming and we certainly hope that you have suggested a method which will improve tank construction, whether it is an Imhoff tank or not."

Chicago, Ill., April 6, 1920.

(Signed) Pacific Flush Tank Co.

Your kind letter of February the 27th was received here. You enclosed a copy of your paper on "Imhoff tank operation."

European sewage, from analyses, and from my own inspections, certainly contains less fatty matter than our own, particularly the sewage of our smaller towns. Therefore, it is quite natural that the behavior of sewage here may be, and often is, different from its behavior in Europe after it has reached disposal plants and is there treated.

The experience recorded in your paper is quite interesting. I am sending the copy you sent me to Dr. Imhoff for his information. He may send me a reply, with some comments, of which I will then send you a copy. I hope myself to go to Europe this summer and may see him and get some further data regarding the experiences during the last eight years, since I was there.

Let me give you some of my own comments:

Your word "sludge" does not cover Dr. Imhoff's meaning of the word. You speak of "sludge and scum on the surface of the upper tank" as being "3 ft. deep or more." Imhoff's sludge never rises to the top. It always either sinks to the bottom or goes off as suspended matter with the effluent. It never accumulates at the surface. The settled sludge, i. e., the heavier settling particles, if three to six months old, always flows out of the discharge pipe with the consistency of thick cream, when it is ripe, and it has no putrefactive odor, but only a slight odor, which resembles that of tar. If the sludge is putrescent, it is not yet ripe, and still contains sulphur bacteria, which have not yet been exterminated by the multitudes of bacteria, generating chiefly methane and carbon dioxide gas, both of which ordinarily escape from the tank and neither of which has an offensive odor. The sludge should never be withdrawn until it is ripe.

The Imhoff sludge, when withdrawn, runs into small channels made in a bed of sand, to a depth of a few inches only, then it dries out within a few days of clear weather and becomes friable, and is no longer sticky and then it has no odor.

If these conditions do not exist, then either the sewage is different from the European sewage, or our treatment of it has not been proper. The latter is often the case. Many consider the process wholly automatic under all conditions. This is not correct, and the treatment always needs intelligent care and supervision. The sewage must remain in the upper tank into which its first flows, long enough to flow slowly enough to allow of sufficient sedimentation, so that the effluent is fairly clear. This is not always accomplished, particularly when the center flow is much more rapid than the side flow, which is in fact a common cause of imperfect results and should not be. It can be prevented by proper baffling.

Our sewage, although much more dilute than the European sewage, has much more greasy matter. The greater dilution necessitates a somewhat slower flow for sufficient sedimentation. The greater amount of grease with us rises to the surface and forms the scum which is sometimes several inches thick. This scum is the most troublesome feature of the treatment. Our American sewage is sometimes greasy enough to make it worthwhile to let it pass through a grease trap of sufficient size and proper construction, so as to catch the grease and allow it to be removed separately. Hotels and eating houses, if not all houses, ought to have a grease trap on their private sewers, before these discharge into the public sewers.

Grease decomposes more slowly than the easily putrescible matter but when it does decompose its heavier parts also sink to the bottom. I think it is best in some cases to skim off this scum, drain it in bags, or press it into cakes, and then burn it together with some light combustible matter, or bury it in shallow trenches, where it decomposes in one or two years, depending on the season of year or climate.

If the effluent covers the filter bed with a "thick leathery deposit" and clogs the soil, then the sewage has evidently not settled long enough, or the channel surfaces on the filter bed have not been raked often enough to break up the film that may form. In England the filter beds are sometimes raked over twice a week.

A very small addition of milk of lime to the sewage of small towns, particularly if this is acid, will

help coagulation, hasten the sedimentation, and produce better sludge.

If the effluent smells under the right treatment, then the sewage when reaching the tank is older than it should be or need be, if the sewers are properly graded, of smooth interior surface and frequently flushed. The sewage will then flow with sufficient rapidity so that it will not become foul before reaching the outflow. The remedy is, better attention given the sewers and greater cleanliness in them.

Miami, Florida, March 15, 1920.

(Signed) Rudolph Hering.

I am taking the liberty of sending you under separate cover some prints of the proposed Imhoff tank, and if you care to, I would be glad to have you criticize the design.

I must say that your article is somewhat of a "bolt from the blue," as I know of many Imhoff tanks that have been and still are operating without any of the troubles which you have found. Our problem is one of domestic sewage only, without trade wastes of any kind.

Bids for the Ames work will be opened June 7th, with little chance of getting a satisfactory contract, due to material and labor conditions. There is yet time to make such changes as would permit of either method of introducing the sewage into the tank.

Thanking you for any suggestions that you may see fit to make.

Ames, Iowa, May 26, 1920.

(Signed) P. F. Hopkins,
Mgr. Dept. of Engineering.

Mr. Alvord's reference to the Madison plant is evidently intended to refer to the manner in which he designed it and not to the manner in which it was actually built. In its present state it is practically a septic tank with separate sludge chambers.

Dr. Imhoff evidently intends to have the sludge in his tank of a character to suit his own liking. I wish we could do that in this country. Possibly if he had some of the American sludge to contend with he would change his definition. As the Irishman said, "The ding" stuff won't work that way.

It is my opinion that American sewages are gradually but positively changing in character. The creamery, cheese factory and condensary wastes have a marked effect on sewage where the proportion of such waste is large as compared to the volume of domestic sewage. The automobile garage is getting to be quite a factor in producing a waste that is most difficult to handle. Where all or even a part of the storm water enters the sanitary sewers the oil from oiled streets and the oil and grease dropped from automobiles are also factors.

SOME FEATURES OF GARBAGE DISPOSAL BY HOG FEEDING AT BALTIMORE, MD.

The disposal of garbage by feeding to hogs has been in effect in Baltimore, Md., since May, 1919.

The farm, situated on Bodkin Creek (just north of the Magothy River), is owned by the city and leased to the American Feeding Company. The city pays the cost of collecting garbage in the city and pays for towing it to the farm. On the other hand, the American Feeding Company pays the city for each ton of garbage 3½ times the average top price per pound of live hogs for the month on the Chicago market, so that the price received by the city fluctuates with the value of the hogs.

The financial result of these operations for four months late in 1919 was that the city received about $7,000. The cost of towing during this period was about $2,500, yielding a profit to the city shown not only by the actual receipt of money but by avoiding altogether the payment of money to a contractor, as in previous years, for the disposal of garbage, usually some $75,000 a year. This justifies the statement that the system is satisfactory to the city.

VIEWS OF EQUIPMENT FOR HANDLING GARBAGE AT BALTIMORE FEEDING FARM.

Top: Pier Showing Garbage Scow, Austin Crane, Hopper, Track, Cars and Locomotive with Bucket of Garbage About to be Dropped Into Car. Center: Plymouth Locomotive Hauling Loaded Cars and Dumping Garbage on Platform. Bottom: Feeding Platform of Concrete with 24-in. Gauge Track; Hog Lot Fences on Either Side.

Equipment Used in Handling Garbage

The garbage is collected by the city, loaded in scows and delivered to the American Feeding Company alongside the company's dock. The feeding floor is of concrete 33 ft. wide and 700 ft. long and located about 1,400 ft. from the pier. The garbage is unloaded from the scow with an Austin Model 5 DL machine, located on the pier, and equipped with a 1 yd. Haiss clamshell bucket. A

24-in. gauge industrial track extends from the pier to the feeding platform and through the center of it from end to end. The garbage is dumped through a hopper into 1½-yd. Koppel steel rocker dump cars and hauled to the feeding floor, with a 3-ton Plymouth gasoline locomotive, where it is dumped. The hogs are then turned in on it.

During the summer season from 5,000 to 6,000 hogs are fed at this farm and during last winter about one-third of that number were fed. The accompanying views of the feeding platform and equipment were furnished by Mr. Walter W. Cooper, manager of the American Feeding Company.

DESIGN AND CONSTRUCTION OF THE MEMORIAL BRIDGE AT DES MOINES, IOWA

By K. C. Kastberg, Secretary, Board of Engineering Examiners, Des Moines, Iowa

On January 9, 1920, the following resolution was adopted by the city council: "That the University Avenue Bridge be designated and named 'Memorial Bridge' in memory of those from Des Moines who fought in the World War." Although operations began before the period of strife, the major part of the construction proceeded during the war.

The structure was first known as the North Street Bridge, named after the old street, and later University Avenue Bridge, because this avenue is now absorbing old North Street in connection with the development of the city boulevard system.

Location

The bridge site is a mile up the river from the west side business section. To the south is a flat expanse of sand, while to the north lies the picturesque woodland, the aesthetic qualities of which remain ungathered; the bridge stands out in bold relief flanked by unsymmetrical surroundings. Viewing the profile from the south, the east bank drops abruptly a distance of nearly 75 ft. to the water, and about 600 ft. across; the west shore gradually slopes back for three-quarters of a mile in a concave curve, finally reaching about the same elevation as the east side. The river separates the residence sections, the better types of houses on the high lands, while the more lowly ones dot the bottoms. Along the ledge of the cliff the Chicago and Northwestern railroad has its right-of-way and about 1,000 ft. from the west shore, the interurban tracks lead from the city.

Need of the Improvement

There had been no direct path across the Des Moines river at this point, only a round-about course, either over the Sixth Avenue bridge, around the bend and a mile to the north, or over one of the four down-town bridges, almost a mile to the south. Two of these were also new bridges, just being completed. That a bridge would be necessary soon was apparent, although there was some opposition both in regard to the advisability of building a bridge at this time and also in regard to the exact location, the latter having been considered before the University Avenue Boulevard plan was fully completed or comprehended.

Type Chosen

The physical requirements included the spanning of approximately 600 ft. of stream at normal water level and about 1,500 ft. during high water, also the northwestern track and the connection with existing grades at each side of the river. When the gates of the new dam, three-quarters of a mile down stream were closed, the normal water level was raised 6 ft. to elevation 13.0.

Too steep a grade was to be avoided as this might not invite traffic. With the decision of a 3 1/3 per cent. grade as the maximum, the problem of handling existing conditions remained.

On the east side University Avenue is intersected about 500 ft. from the edge of the bluff by East Seventh Street, the first street extending north and south. This, as well as Pennsylvania Avenue, further east, would be the logical street for approach. With the exception of that part of University Avenue between the bluff and East Seventh Street, all the streets were narrow, and though improved with paving, curbs and walks, lay practically level, and were lined on both sides with modern residences. On the west side the shore was barren, except for two or three cottages between the river and the interurban tracks, but further west the streets were well built up. Here, again, University Avenue was very narrow, and like the side streets, was not paved.

Because of the interurban tracks, the west approach was fixed to begin either at this point or farther west in order to provide clearance. The elevation, 400 ft. west, is 10 ft. higher than the track, elevation 21.0, and by careful manipulation of the several streets, the main grade up to the crossing might have been kept well under 4 per cent. Then beginning a 2½ per cent. grade 26 ft. above the track and extending it east, we would reach the top of the bluff. In this manner existing grades would have remained practically unmolested at both ends. But such a plan would have meant a very large and much more expensive structure. Controlled mainly by financial considerations, the verdict placed the beginning of the west approach at the interurban tracks with a uniform grade of 3 1/3 per cent. to East Seventh Street, and a 2 per cent. grade to Pennsylvania Avenue. A 7-ft. cut at Seventh Street helped provide earth for the west approach fill, where an earth fill was chosen instead of a concrete viaduct because the cost was $50 less per lineal foot.

Size

The bridge proper is a reinforced concrete structure of the open spandrel type with six arches. Beginning at the west with arch No. 6, a 103-ft. span, we have 115, 127, 139, 151-ft. spans, and arch No. 1, an unsymmetrical span of 128 feet over the North Western tracks. The rise is increased in proportion to the span length with the apparent spring line constant at elevation 21.0, the top of the pier opening. Each arch is made up of three ribs, the middle one 7 ft. wide and the outside ones 4½ ft. wide.

In addition to the regular live load of 100 lbs. per sq. ft., plus 25 per cent. for impact, the bridge was designed to carry two 50-ton interurban cars, coupled on tracks 10 ft. on centers.

The floor is made up of slab, beams and girders, the latter occurring at the panel points, 12 ft. apart. At the expansion joints the girders are 5 ft. deep, otherwise 4 ft. Two expansion joints are either 7 or 8 ft. apart at each pier, depending on the pier width that was increased

for the larger arches. Joints also fall near the center of the arches from 24 to 36 ft. apart. The roadway is 42 ft. between curbs, paved with vitrified brick and pitch filler, laid on a 1½-in. sand cushion. At the center, the slab is 9 ins. thick and decreases at the curb to 7 ins. where it drops 3 ins. The top of the 8-in. curb is grade, making the 6-in. crown of the finished pavement 2 ins. below grade. Cantilevers support the 6-in. walk slab, 6 ft. wide from curb to inside base of handrail. The walk slopes 3/16-in. to the foot.

The over-all width of the floor is 57 ft. and the length is 798.5 ft. On each side a cantilever-supported stairway, 7 ft. wide, drops toward the west abutment to a landing, then turns inward to another landing, finally reaching the ground level on each side of the middle rib. Eventually this will lead the pedestrian to a boulevard passing under arch No. 6.

The waterway required was not considered because of the height of this bridge.

Materials

The materials included principally: 57,000 ft. of squared lumber, 355 tons of reinforcing steel, 20,000 ft. of false work piling, 14,580 bbls. of cement, 7,333 tons of sand, 11,533 tons of crushed rock and 8,600 ft. of foundation piling.

Labor

All labor consisted of local help which was divided into common labor, form builders, mechanics, finishers, riggers and engine operators, teamsters, day and night watchmen and foremen. The maximum number employed per day was about 125. Remarkable loyalty was displayed in spite of keen competition between gangs doing similar work. For a short time during the war labor tightened up a little and efficiency dropped.

Late in 1917 when the work first began, common labor was paid about $3 for nine hours, while toward the close, the rate varied from $4.50 to $5.40. The carpenters' rate advanced from $4.50 to $6.30 and $7.20, teams from $6 to $8 and foremen from $5 to $7.

Cost

The total cost of the bridge and approaches was $390,867.15. Of this amount, $355,800 included the bridge and west approach. Deducting $58,712 for the fill with brick paving on a 5-in. concrete base and two 5-ft. walks, left $297,088 for the bridge structure. The cost of grading the east approach, providing 5-ft. walks, curbing and asphalt paving was $35,067. Although no definite figure is yet at hand, it might be well to speak of the whole east side improvement here. East University is being widened at present as far as Ninth Street, but the part included in the bridge contract extends only to the west line of Pennsylvania Avenue. The bridge contractor widened University Avenue to 42 ft. between curbs, and the south property line was shifted to make the street 91 ft. wide. East Seventh Street is also being changed from 22 to 30 ft. between curbs, and the west line will be moved to make this 79 ft. wide.

The above changes necessitated the razing and removal of a great many houses, both for the benefit of the better approaches provided and the acquisition of a park site between Seventh Street and the bridge. This park will be named John Burke Park in honor of an East Des Moines boy, incidentally a former member of the city engineering department, who died of wounds in France.

There were a few small extras for such conditions as the investigation and protection of a large sewer that lay in the vicinity of the east abutment, also the provision for a pair of small wing walls for this abutment. Although work on the east approach was classed as an extra in the monthly estimates, it was really a part of the bridge contract.

Financing

The improvement was financed by a bond issue to be liquidated by the levy of a special tax. The contractor received compensation on the basis of monthly estimates, less 15 per cent., for work completed and for materials received.

Methods of Construction

The west shore was chosen for the plant and storage site, as well as the point to begin operations. A spur from the interurban tracks was led from the south for some distance straight along the river bank and ended just north of the bridge. A steel guyed derrick west of the track unloaded crushed rock, sand and piling, and served the hoppers over the loading pit. Lumber was stored near the wood shop, south of the rock pile. Many of the curves were laid out on the wood shop platform that served as a large drawing board, and after the false work trusses had been assembled in sections, they were thrown into the river by the derrick and towed by motor boats within reach of the derricks that set them in place. The cement storage house and plant occupied the space between the storage piles and the bridge. The mixer was driven by a horizontal steam engine and was charged from a hopper above into which the incline compartment car from the loading pit dropped its load. Office, blacksmith shop and steel storage were north of the bridge.

Dry excavation for the west abutment and pier No. 5 was followed by the driving of foundation piling about 12 ft. long after being sawed off, 274 ft. for the abutment and 150 ft. for the pier. The penetration per average of the last five blows was inserted in accordance with the Engineering News formula, supporting power in pounds is equal to the weight of the drop hammer in pounds multiplied by the length of fall in feet and divided by the quantity one plus the penetration in inches. This always indicated more than the required 20 tons as called for in the specifications. Weight of hammer used was 2,200 lbs. and the drop was 26 ft. While equipment was being assembled, these pile and foundations were handled in a temperature sometimes 20 deg. below zero, but the concrete was very well protected with steam pipes, salamanders and canvas.

A stiff-leg derrick excavated for and built the first river pier, No. 4, which extended just far enough to be within reach when the mast was placed on piling near the shore. The cofferdam for this pier was typical of all four used, although No. 3 was the largest and No. 4 was built during the most severe winter weather. The whaling timbers were framed on the ice for a rectangular cofferdam, 20 x 65 ft. Then by sawing the ice around and from the weight of several frames, the sinking and placing was accomplished. Four by eight grooved wooden sheet piling 20 ft. long was driven and backfilled. Except for a few slight blow-outs, this and all other cofferdams went down in good order. Two 6-in. centrifugal electric-driven pumps were used on all cofferdams. In-

termittent pumping, and removal of the 5 odd feet of sandy, muddy material of the river bed, exposed the rock. This presented a fairly smooth surface so that 1¼-in. dowels were placed, projecting into the rock 2½ ft. A 5½-ft. test hole gave further conclusive evidence of sufficient thickness. The rock at the other piers was very rough.

The west abutment with its retaining walls and piers No. 4 and 5 were poured almost entirely by means of wooden spouts hung from cables between the large tower, 104 ft. high, and various smaller towers. On April 8, 1918, when the abutment was half poured, fire wiped out the complete mixing plant and storage house full of cement, but left the big tower intact and did not even scorch a form.

The traveling derrick passed over the piers at about elevation 22, and with the aid of the barge derrick placed all of the false work and cofferdams, except pier No. 1 and the east abutment.

The umbrella section of each pier began at elevation 17.0 and was poured before the arch between. Then the pier was built up to grade before the arch forms had been completed.

The total form work was 1,154,000 board feet and the concrete amounted to 10,200 yds., divided mainly into 1:2:4 and 1:3:6 proportions. The former was used all over except for railings and footings. Each footing contains about 260 yds. at 1:3:6 mix.

The outside ribs contain ten 1⅛-in. square bars, top and bottom, and the middle has 14. One ½-in. square hoop is 24 ins. on centers. The roadway slab is reinforced with steel at top and bottom.

The beam side and bottom forms were made of 2-in. lumber as well as the columns, struts, and parts of the handrail and stairways. No. 9 and 10 wire was used in wiring the forms, except the columns which were yoked with four by fours, bolted. The sides of all ribs were bolted with rods in four sections so that the short ends could be unscrewed when the forms were stripped. For ribs, piers, pilasters, retaining walls and foundations, 1-in. sheeting was studded with two by fours, usually on 2-ft. centers, and whaling, two 2 by 6's on 3-ft. centers.

Pier No. 3 was made an abutment pier on account of the danger of a shut-down that might result from war restrictions. Fortunately all material to complete the work had been delivered to the site, except cement, the storage capacity of which was limited to three carloads, but as soon as arch No. 6 was completed a shed was made of it by hanging heavy canvas from the roadway on each side and laying a heavy timber platform well out of reach of high water, which would contain nearly all the cement required.

High water reached elevation 21.0 on June 6, 1918, during the flood, just as cofferdam No. 2 had been cleaned and pumped out. Motor boats encountered and tied up all floating trees and debris upstream and no damage was done. The spur track was completely inundated as well as a few of the low spots back on the interurban track.

The arches were poured with special care, giving due consideration to the balancing of loads and the effect on adjacent arches. The floor was also placed in a systematic manner. A trestle was built along the centerline of the bridge about 6 ft. above grade and this was extended as fast as the false work was set up. Three rebuilt Ford cars with flanged wheels served as locomotives, hauling hopper cars for concrete, and flat cars for lumber and supplies. Part of the time the trestle train spouted to another train that followed the traveling derrick in building the piers. Finally, after the arches were poured, by providing switches and a steam shovel on the east side, three trains of four cars each transported 25,000 yds. of earth to the fill. Gravity brought the loaded cars over and the Fords hauled them back.

Meanwhile about 10,000 yds. of earth had been hauled into the fill by team until the time of the flood, which, aided by rains, made it too difficult to go on. Then a 10-in. sand pump on a barge was rented to pump in sand at the rate of about 500 yds. a day, until an additional 10,000 yds. filled the low places.

The east abutment plan called for 180 foundation piles, but when the excavation reached the point where the bottom of the foundation was to be, coal and old mine struts were uncovered. The foundation was extended 2 ft. lower for the material was too hard to drive piling into. A 2-course brick sewer, 48 ins. in diameter, was found to lie in a diagonal direction 28 ft. below the abutment foundation. Upon digging a 6-ft. hole to this sewer through very hard material, slate shale, fire clay and coal, it was discovered that it had been tunneled and not backfilled. The sewer was tapped on top with an 18-in. sewer pipe that extends up through the back of the abutment without affecting the strength of the middle rib. The hole was then filled with lean concrete and a manhole set in the bridge floor. A heavy rainfall caused an earth slide that delayed progress a little, just before pouring the foundation.

The bridge walks and rails were poured during the summer of 1919, and although wetted down, the walks showed hair cracks. The men stripping forms under the floor remarked about the stifling heat at this time.

All the large and intermediate handrail posts were poured in place as well as the rails, but the small post caps and the spindles were precast.

During the cold winter months canvas was hung from the roadway, and with the aid of suspended salamanders delays were prevented, although this method was somewhat more expensive.

Progress of the Work.

Actual construction began in July, 1917, when the contract was let to the contractor by the city council. The general progress was satisfactory considering the abnormal conditions affecting the work. When the east side grading was under way, injunctions caused delays. The bridge proper stands completed.

East University Avenue is finished, but south East Seventh Street stands in a partly graded condition since the condemned houses have not been razed and removed. North East Seventh is practically intact, presenting a sheer cut-off of 7 ft. The fill is gradually being completed and will be paved as soon as settlement will not be enough to injure the paving.

A design has been completed to bridge the interurban tracks to make a safe crossing connecting the fill with West University Avenue although at the present time the light traffic on the railway does not warrant the construction of a viaduct. West University Avenue has been widened and graded and the contract let for the paving.

Since $35,000 remained to be paid the contractor, who was unable to finish the work on account of the injunctions, a new agreement was made with the city on Feb. 13, 1920. The contractor was released from the original large bond substituting a smaller one. He was paid $16,000 which left $19,000, the cost of completing East Seventh Street on the original unit price basis, to be done as soon as restrictions were removed, and of providing earth to finish the fill. The contractor waived all claims for damages.

Personnel.

The contractor was William Horrabin of Iowa City, Iowa. The design was prepared by Dana E. Thomas who was retained as superintendent until February, 1919, when he resigned, and Edward M. Mahl was made superintendent. The work was handled by the Department of Streets and Public Improvements, John W. Budd, superintendent. Engineering and supervision for the city by: Karl C. Kastberg, City Engineer; John M. Tippee, Construction Engineer; Herbert W. Hahn, Resident Engineer of Construction.

The foregoing paper by Mr. Kastberg was presented at the 1920 annual convention of the Iowa Engineering Society.

HANDLING MOTOR TRUCK TRAFFIC ON TRUNK HIGHWAYS OF MARQUETTE COUNTY, MICH.

By K. I. Sawyer, Superintendent Marquette Board of County Road Commissioners, Ishpeming, Mich.

The handling of motor traffic upon our main trunk highways through the country is rapidly becoming as serious a problem as traffic control has ever been in our cities, and at some points it has been necessary to borrow the methods of city traffic control for application to the handling of traffic upon more congested trunk lines.

One interesting illustration of this is in Marquette county, Michigan, where the traffic on the trunk line between Marquette and Ishpeming has become heavy enough to make travel dangerous unless some means of control is adopted. The main road between Ishpeming and Marquette is a beautiful example of waterbound macadam built of hard green trap rock. About four years ago the traffic on this road became heavy enough to break the bond in the macadam and the road started to ravel out. The writer rebonded the portions that were most badly ravelled, adding limestone chips as a binder and seal coating with Tarvia B. The whole road has received two light applications in these four years and is now presenting a smooth and perfect surface to the traffic.

This road was originally laid out as an ore teaming track from the iron mines at Ishpeming to the boats at Marquette, and, of course, was designed only for team travel. Inasmuch as this road drops 900 ft. in seven miles through a hilly country, there are numerous curves and grades. The maximum grade is 6 per cent, but some of the curves are of a higher degree than is now considered good design for present motor traffic. The traffic, which has now passed the 1,200 mark per ten hour day, was beginning to get dangerous to itself, inasmuch as the visibility was low on these curves, due to the shoulders of the hills and the heavily timbered country which borders the roads. To relieve this situation the writer painted white 8 in. center lines upon the black surface of the road upon the more dangerous curves, with an arrow pointing down the right hand side of the road at either end, this to counterbalance the tendency of auto drivers to hug the inside of a curve regardless of the danger of hitting the traffic approaching which might be invisible to them at the time. The effect was immediately apparent, as the auto drivers accustomed to obeying control signs in the city immediately responded to the appeal of the white line and kept to the right hand side of the road, and the immediate reduction in the number of accidents indicated that the scheme was worth while.

The writer has had this center line system of control in use for three years, and is well satisfied that it is the best thing he can do to protect traffic using this road. The road is the main highway between two rapidly growing communities, and the wonderful country through which it leads is drawing tourists in greater numbers every year, so that his problem never becomes less but rather tends to become greater.

The white paint used for this work is the tpye of whitewash prepared according to the formula used in the U. S. lighthouse service. The patrolman touches up the center line every Saturday morning, but unless the rains are especially severe there is little difficulty in the lines lasting a month without attention.

TYPICAL TRAFFIC CONTROL MARKINGS ON SURFACE OF MARQUETTE TO ISHPEMING (MICH.) HIGHWAY.
The left view illustrates the sharp curves and steep grades on this macadam road, built in 1908-1909, and resurfaced in 1916 with Tarvia B. The pictures were taken in August, 1920. The 1920 traffic counts at this point show 900 to 1,600 vehicles in a 14-hour day. The right view shows a 6% grade to a railway crossing on each side and a rock bluff adds to the low visibility. The paving markings have reduced accidents.

The scheme has been so successful that the writer does not hesitate to recommend it to other county road engineers who have similar problems to meet. Not every road surface lends itself so readily to center line painting, for the smooth black surface in this case was ideal to make the white center line stand out in sharp relief. Some color scheme can usually be worked out so that the traffic can be reminded that the right hand side of the road is the only side that properly belongs to them. The motor public as a whole is only too willing to take a hint which is for its own safety, and the scheme is sufficient reminder to keep traffic within bounds and allow a much heavier traffic to use the roadway without danger, which is not usually the case on our county highways.

ENGINEERING PHASES OF THE WATER SITUATION IN CALIFORNIA

By Stephen E. Kieffer, Consulting Engineer, Mechanics Institute Bldg., San Francisco, Cal.

Easily first among the factors affecting California's prosperity is its water supply. Unusual conditions have created a critical situation calling with unexpected suddenness for the solution of water supply problems of the first magnitude, the solution of which must rest with the engineering profession. Hence it is thought that a brief statement of the principal existing conditions, and of some of the problems to be met, will be of general engineering interest.

California, within its 800 miles of length and 200 miles of width, runs the gamut of things climatical from rainless Death Valley on the south to the excessive rainfall of the Coast forests on the north, and the lofty Sierras on the east to the Pacific Ocean on the west. But for the most part the State is semi-arid, with an average rainfall of from 10 to 30 ins. per season over the agricultural valleys. This rainfall is distributed seasonally from about September to March, leaving a so-called "dry" season of approximately five months each year. During this period irrigation is practiced.

The water development of the early days was principally carried out by the miner of the Sierras for the extraction of gold. But gradually, with the passing of the cattle and wheat kings of the valleys and the increase of population, agricultural development made increasing demands and the water of the mountains was carried to the valleys. The first easily acquired water rights were easily and cheaply developed, but through a long period of years up to the present time water has become increasingly difficult and expensive to obtain.

Unprecedented Demand for Irrigation

The 1920 census will undoubtedly show that California has made tremendous strides, and will take position well to the front among the states, in population. Every indication points to a continuous and rapid growth. Normally such a condition of affairs might be expected to increase the demand for irrigation water, since the natural climatic attractions of California, and the productiveness of the soil under irrigation, lead the settler to agricultural and horticultural pursuits. But to the war only, with its demand for increased output of the soil and high prices, can be attributed the abnormal demand for water of the past three years. To the normally accepted belief in the physical necessity for water to produce certain crops there seems to have been added a sudden and intensely developed realization of its value in increasing production along all lines. New crops also, such as cotton and rice, are assuming great proportions. In conjunction with this condition has occurred the most prolonged period of low rainfall ever recorded in the State. The natural result has been that the present demand for irrigation is unprecedented in California, and energetic efforts are being put forth to procure a water supply in every section and for every class of crop that irrigation will benefit. This activity is no doubt hastened by the awakened realization that at 100 per cent. development the water resources of the State will fall far short of its ultimate needs.

Great Demand for Water for Power Purposes

Nor is the demand for water less acute for power than for irrigation. California has led the world in the development of hydro-electric power and its long distance transmission. As the surface sources of irrigation water supply became more difficult and expensive to develop, the pumping of underground water was resorted to through the use of electric power. This consumption has grown to enormous proportions, thus establishing a never ending and ever widening cycle of interdependence. Hydro-electric power and irrigation development will be more intimately connected in the future than in the past. Water stored in the mountains and used for power will be used through surface canals for valley irrigation, and again used for pumping through the agency of the power first created. A review of the present water situation, and its engineering phases cannot, therefore, be confined solely to its application to irrigation. Nor is the power phase of the subject confined to agricultural development alone, but it affects every city and town where electric power is supplied. From this angle the dependence upon water is further emphasized and made of the first magnitude due to the present critical situation resulting from the unprecedented demand upon the State's fuel oil supply, the visible reserves of which it is claimed are being drawn upon.

Dry Years

With the increasing demand for water the influence of seasonal variations of supply, dependent upon rainfall, become more important. A marked departure in precipitation below the long time average marks the "dry" year, as differentiated from the average. No fixed rules can be laid down, but in general terms the records seem to indicate that in California single dry years occur on an average about every 5 years; a cycle of two successive dry years every 12 to 15 years, with a three year dry cycle unknown in the past as recorded. History is now being recorded, however, and the State is passing through the third successive dry season. Present indications are that the emergency will be met, both as to irrigation and power requirements. But the margin of safety has been used up. All minds refuse to contemplate the unheard of possibility of a fourth successive dry year, or a repetition of the present conditions in conjunction with the future certain growth of population and agricultural development. Guarding the future against such a contingency is the awakening motive among all classes and interests.

The solution of the problem must eventually be worked out by the engineering profession. This article is only intended to state briefly existing conditions, and point out some of the future projects involved.

California is roughly divided by its mountain ranges into a few principal geographical and drainage divisions, which have climatically marked and separated physical conditions, without relation to each other. East of the Sierra Madre mountains, in the southeast corner of the State, is the great Imperial Valley, fed by the waters of the Colorado River, and having no relation to or bearing upon the water supply of the rest of the State. South of the Tehachipi mountains, and between the Sierra Madres and the sea, is the region popularly known as Southern California, with Los Angeles as the central city. Intensive application of water to high class crops has long since resulted in the development and use of all of the water tributary to this region. This supply has been augmented by water from the eastern slope of the Sierra Nevadas and carried over 200 miles through the Tehachipi mountains by the great Los Angeles aqueduct. While primarily for municipal use this water is also used for irrigation. From the Tehachipi mountains on the south to the Siskiyous on the north, with the Sierra Nevadas on the east and the Coast Range on the west, there extends for 500 miles the Great Valley of California, containing 20,000,000 acres of cultivable and irrigable land. Probably half of this will never be irrigated for lack of a water supply. Here is to be staged the scene of the State's greatest development, with its foundation of prosperity resting upon the water available for irrigation and power uses. While one physically and geographically this Great Valley is separated into two general drainage areas known as the San Joaquin Valley on the south and the Sacramento Valley on the north, these names being taken from the principal rivers draining the valley north and south to a confluence and outlet at the Bay of San Francisco. Numerous important cities and towns, including the Capitol city of Sacramento, are scattered throughout the length and breadth of these valleys, while at their natural outlet at the Golden Gate are located the cities of San Francisco, Oakland, Berkeley and others of the municipal area with a combined population of about one and one-half millions.

A Great Irrigation Development

Irrigation of this great valley has been practiced in varying degrees for many years, dependent upon location and crops, with the greatest development where water was cheapest and most plentiful. Practically the entire water supply comes from the streams flowing from the continuous and unbroken range of the Sierra Nevada mountains on the east. Throughout the length of 500 miles fourteen major rivers, having their sources in the Sierra summits, and many secondary streams of large size, enter the valleys. The Coast Range contributes no water to the west side of the San Joaquin Valley, but a considerable volume to the Sacramento Valley. The Sacramento Valley on the north is naturally much better watered than the San Joaquin on the south, with just about double the average rainfall (approximately 20 ins. as against 10 ins. per annum). The inevitable result of this condition was the slower awakening to the value of irrigation in the Sacramento than in the San Joaquin Valley. All streams entering the San Joaquin Valley were long ago utilized to their maximum, and for years past practically no water has flowed to the Bay through the lower reaches of the San Joaquin River during the summer months. In the Counties of Kern and Tulare, forming the southern end of the San Joaquin Valley, the entire flow of the Kern, Tule, Kaweah and a portion of the Kings rivers (all of large size) is retained south of the Kings River barrier and accumulates in wet years in Tulare Lake. Only three times in sixty years has this lake overflowed to the north into the San Joaquin River and thence to the sea. The waters of Kings, San Joaquin, Merced, Tuolumne, Stanislaus and Cosumnes rivers are utilized through great canal systems to irrigate as far north as Stockton, the most northern city of the San Joaquin Valley. Greater demands for water in this valley can therefore only be met by greater development through reservoir storage or pumping, and the problems involved are fairly fixed in their character and scope.

Beginning at the city of Sacramento and going north for 200 miles through the Sacramento Valley a very different set of conditions is presented. Here a more abundant rainfall, combined with a resulting lessened interest in irrigation due to the greater volume of dry farming, created a comparative abundance of stream flow. The Sacramento River was a stream of large volume at the time of lowest seasonal flow throughout the 200 miles or more of its length. At Sacramento the normal flow of the river during late summer was generally from 5,000 to 6,000 second feet. Navigation by large river steamers is carried on throughout the year as far as Sacramento, and for a good portion of the year to the upper end of the valley at Red Bluff. For those who wished to irrigate there seemed an abundance of water to be had for the taking from the great and (supposedly) inexhaustible Sacramento River.

Such was the situation as it affected the Great Valley above the range of tidal influence of the sea. Beginning at Sacramento and Stockton and extending for 70 miles to the confluence of the Sacramento and San Joaquin rivers at the tidal waters of Suisun Bay the river channels flatten, and through the agency of many sloughs create what is known as the delta region, or "islands," of the Sacramento and San Joaquin. This delta region is of great extent, and the soil marvelously rich. All of the land is reclaimed from overflow during floods by levees. Due to the elevated channels resulting from the deposits of early mining debris the water surface even at low water is generally higher than the adjacent land. Drainage by pumping is resorted to, and either sub-irrigation or irrigation with surface water supplied by siphons over the levees is practiced. Here the problem was rather too much water than too little, and interest was centered in the danger from winter floods rather than from summer drouth.

Effects of the War

Such were the conditions at the time the United States entered the great war in 1917. Then began the great demand for products of the soil at war prices. About that time also a new industry was being established in the Sacramento Valley—that of rice culture. Under the war stimulus this grew by leaps and bounds, until in 1920 the crop covers 150,000 acres, and is valued at $60,000,000, thus ranking the Sacramento Valley as one of the great rice producing sections of the world. With the advent

of this rice culture, combined with the general irrigation awakening, every drop of water in the valley is in demand several times over. Applications made to the State Water Commission up to May 20, 1920, for water from the Sacramento River proper aggregated 10,502 second feet. The permits granted to the same date (the last on September 29, 1919) aggregated 3,901 second feet. During the low water season of 1919 the flow of the Sacramento River at Sacramento averaged about 2,500 second feet. It is therefore apparent that the pending applications now on file are two and one-half times the low flow passing Sacramento last season, and the granting of any of them is a matter of moment to the delta land owners below Sacramento. During the present summer the river flow at Sacramento has been kept about as in 1919 as the result of a mutual agreement between all the present water users in the Sacramento Valley above Sacramento, who consented to accept the apportionments of a Water Master appointed by the State Water Commission. No new water permits were granted by the Commission in this territory.

A further effect of the up-river diversions and the lessened stream flow past Sacramento has been to permit the retrogression of the tides, with reversal of the current and resulting salinity of the river water, many miles further up the rivers than ever known before. This salinity has forced the towns on the lower rivers that pump water directly from the streams to barge water during the late summer months from many miles up stream, while the irrigation of the delta lands is threatened. Further diversion of water from the upper Sacramento it is claimed will imperil and destroy the productivity of the delta region. The upper valley and delta land owners have each perfected organizations preparatory to defending their positions in Court. The city of Antioch, backed by the delta owners, has brought suit for an injunction restraining the rice growers of the upper valley from diverting water for their crops, unless strictly riparian to the streams. This is the preliminary skirmish in a legal battle that, unless checked by a physical solution, will involve hundreds of millions of dollars, and continue for years. Neither side should lose unless the State is to suffer.

Another element entering the problem is the fact that the Sacramento River is a navigable stream and under the control of the War Department. Diversion of water to the detriment of navigation must therefore have the sanction of the Federal government.

Coincidental with this crisis in the Sacramento Valley arising from the growth of rice culture the production of cotton is making rapid strides and assuming large proportions in the San Joaquin Valley, and this combined with a phenomenal increase in fruit culture is putting great pressure on the water resources there. To meet the emergency pumping has been resorted to in both valleys to an undreamed of extent, with a resulting serious lowering of the general water table, and such a draft upon electric power that its use has had to be regulated and prorated under the direction and control of the State Railroad Commission.

The above statements set forth only the high lights of a big situation awaiting treatment. Great numbers of minor problems of irrigation development, in the aggregate large, cannot be touched upon. The entire situation is rendered critical, and in a measure superinduced, by the fact that the season of 1917-18 was one of very scant rainfall and runoff, with resulting abnormal low water conditions during the summer of 1918. This has continued during the years 1919 and 1920, with a cumulative and alarming falling off in stream flow and lowering of the surface and underground reservoirs.

Storage of Flood Waters

The remedies for the most part are storage of flood waters to equalize and increase the summer flow. Through the assistance of the Federal Reclamation Service it is proposed to impound and control the waters of the Colorado River for the irrigation of the entire Imperial Valley. The San Joaquin Valley is being organized into great irrigation and conservancy districts for construction of storage reservoirs on a great scale. Such reservoirs are now proposed on the Kern, Kings, San Joaquin, Merced, Stanislaus and Tuolumne rivers. From each of these projects a large amount of hydro-electric power will be developed. Coming to the Sacramento Valley various solutions are proposed. The War Department has tentatively suggested the canalizing of the Sacramento River with a system of dams and locks that would protect navigation by lifting the summer water level; permit a greater volume of flow to be diverted, and lesson the pumping head on many projects. Private parties have proposed the construction of a huge tidal dam and locks at the upper end of Carquinez Straits, and below the confluence of the Sacramento and San Joaquin rivers, to reservoir the entire network of channels of the delta region and hold back the salt water from the upper rivers during the summer season. Flood storage reservoirs are proposed by public organizations on the Sacramento River in Iron Canon at the upper end of the Sacramento Valley, and in the Fall River Valley to impound the flood waters of the Pitt and Fall rivers, principal tributaries of the Sacramento. The Iron Canon reservoir will back the water up in the channel of the Sacramento River for 25 miles and impound 600,000 acre feet, and the Fall River Valley reservoir will impound 1,000,000 acre feet. Another proposal, now being studied, is to bring the waters of the Klamath River in Oregon through the Siskiyou mountains by tunnel into the headwaters of the Sacramento. The ultimate solution may be in one or more, or in a combination of all, of these suggested plans. In any event the problem is a big one, and much is at stake.

Very active operations are being carried on to meet the power situation. The Edison General Electric Co. and the San Joaquin Valley Light & Power Co., operating in the south and central San Joaquin Valley; the Pacific Gas & Electric Co. and Great Western Power, operating in the north San Joaquin and Sacramento valleys, are spending millions of dollars and rushing through great electric installations aggregating hundreds of thousands of horse power to meet the present and growing demands.

California is facing a great future, and is preparing to lay the foundation for its essential water supply in a big way, and in that preparation the engineer will take a leading part.

AN ENGINEER'S THOUGHTS ON AMERICANIZATION

By John F. Druar, Consulting Engineer, 512 Globe Bldg., St. Paul, Minn.

We Americans have a larger load to carry than we realize in the assimilation of the foreign population immigrating to our shores. Not only should we welcome these new arrivals, but we must take them from the congested areas and distribute them broadcast throughout our land, unless we are to build Italy, Holland, France, Belgium, Hungary, Germany and other nations right up within our borders much the same as Japan and China have been rebuilt in California.

Most of the foreigners immigrating to this country come with families and the rapid birth increase among these people far surpasses the birth rate of the average American family. Consequently, unless we wish to become in the future subservient to some foreign group, we must take pains to distribute the strangers within our gates and so mix them with our rural population and the people of our small towns that their nationality will become subservient to ours. To improve the situation requires far greater thought than we have given the subject. Americanization societies have sprung up all over the country, and they are doing a good work, but we are not hitting the fundamentals as we should.

For example, an immigrant reaches a small inland town. He may be a section hand on the railroad. He naturally wonders how the county is run. He looks about for the representative of government and may see a tobacco-chewing and spitting town marshal who may use him roughly and sometimes maltreat him. He goes to the postoffice, most likely in a dingy general store or in a poor building, at best, probably poorly lighted and ventilated. He gets a poor impression of the government from the start. Naturally his associates on the section, or wherever he works, treat him roughly, meaning perhaps no harm, but this man is looking for kindness. He gets practical jokes, wrong information, he may be robbed, beaten and broken, he becomes suspicious of everyone and fear and hate of authority become ingrained in his nature where willingness and loyalty should be and could be by the proper treatment.

I have given some thought to the improvement of conditions and can see no good reason why a scheme such as I have to suggest could not be put into general practice.

Decentralization of Federal and State Governmental Functions

Our general government at Washington is becoming too centralized and congested, employes fall over themselves. The vast storehouses of indiscriminate records for various departments are so huge it requires thousands of clerks to file and sort them. No one knows how the government is run except those who visit Washington and make an intensive study of the situation and then, permit me to say, it puzzles them.

How then can we expect the foreigner to grasp even a small idea of our system? The answer lies in decentralization of such functions of government as may be distributed throughout the country at large.

Again the state has centralized its government and concentrated every function at the Capitol.

The local municipal government is usually housed poorly in an unkept hall, where records may and may not be available, and where one is not impressed with the power and majesty of the law and order nor of any functions of the government from the small municipality up.

To overcome this situation at once everywhere would be impossible, but to gradually zone the country and carry out a decentralization process in time would be easy. If congress were to pass the necessary laws and the state and municipal authorities were to co-operate, we might be able to save not only immense amounts in the future but we would surely improve our citizenship wonderfully. The basis is small town and rural community service, the binding of the people together for the good of all. In a city, what interest do you have in your next door neighbor or the man down the block? Really not any, and very often you do not know his name or nationality. Are you self-centered or just why is it? When the citizens of the smaller communities become so self-centered, then our nation will be wrecked.

The Decentralization of Industry

It is for us to avoid such a calamity by the proper distribution and education of the masses. It is just as possible now to build a small factory in a small community and operate it at a profit as it was in by-gone days. You do not have to make all the collars of the world in Troy, New York, nor all of the flour of the world in St. Paul. It could be done as well in other communities. Centralization is a crime for it leaves the small town smaller and the large cities more congested than ever so that disease and pestilence can sweep, like a forest fire, through a whole region.

The man of the small town is just as capable as the man of the city. Often I think that his opportunity for concentration makes him more so. He is not distracted from his set purposes and fights his fights alone and unaided. I understand only too well the fight that will have to be made to undo a great many wrongs of government to suppose that anything like the following program can be accomplished in a day, a decade or in a generation but study can be given it and a start can be made.

Who knows but that some governor will start the fight this year with these suggestions as a basis?

A Joint Public Building

To impress the whole population with the power of the people and the power of self-government, I would have each village and small city set aside a city block in or near the center of the town for the purpose of building a joint structure to house such functions of the federal government, the state departments and the city and county governments as might be necessary for the present time or for the future. We should bear in mind the fundamentals of education, and instruction must be given to the masses, for to build and maintain a nation against the perils from without and within the humblest of our people should know the workings of our laws. The possibilities of their communities should be shown them and their pride stimulated.

If a structure were jointly built by government, state and village, I would suggest that it be a substantial building not necessarily ornate but of such a size as to accommodate the postoffice, such federal offices as might be required and sufficient space for an auditorium and space for the local village offices, rest rooms for both

Spruce St., Sault Ste. Marie, Mich. Constructed with "Tarvia-X" in September, 1919.

Dawson St., Sault Ste. Marie, Mich. Constructed with "Tarvia-X" in September, 1919.

Portage Street, Sault Ste. Marie, Mich. Treated with "Tarvia-B" in 1917, 1918 and 1919.

Easterday Street, Sault Ste. Marie, Mich. Treated with "Tarvia-B" in 1917, 1918 and 1919.

Begin by Saving the Roads You Have—

SALVAGE the roads already built—make *them* adequate to handle the traffic—then go ahead with new construction.

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Tarvia roads are the logical solution of the good-roads problem, offering smooth, dustless, mudless and traffic-proof pavements at low cost. They are proof against the frosts of winter, the thaws of spring, the heat of summer and the rains of autumn.

The maintenance expense of Tarvia roads is small and the resulting saving soon repays the initial cost.

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This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write our nearest office regarding your road problems, the matter will be given prompt attention.

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men and women fitted with the best sanitary appliances. Then, too, there should be space for a government and state library of statisticians where all government and state records would be available for reference use.

The time is coming, if it is not already here, when all state and country roads must be patrolled frequently owing to the increase of pleasure cars and motor truck traffic and to the other swifter means of communication.

Government Manager

This joint municipal building could contain barrack room for a joint village, state and government constabulary, properly uniformed and equipped with police power over certain sections. This would be a splendid, efficient and economical means of keeping the peace. Over such an organization should be a government manager who would be especially trained for this work by taking a university or special training course. This man should make such community work his life study and be paid well. He would act as postmaster, community director, statistician and lecturer on special subjects and should be a representative man, divorced from any political party, and one who could advance from stage to stage and from a smaller to a larger community as his own efforts dictated.

This man would have his fingers on the pulse of the community. Statistics of the soil and crops around about should be worked up by him. His advice or the advice of other government departments would be given freely to the farmer, the local manufacturer or business man. A record could be kept of vital statistics, value, size and quantity of dairy products, stock and other products. Government moving pictures of an educational nature could be given, accompanied by lectures on animal husbandry, crop rotation, sanitation, good roads, drainage, small manufactures suited for the rural community and many other interesting subjects.

The time is coming when the small community must become more self-supporting for the congestion of our railroads is such that if finished products can be produced in zones, the railroads can be materially relieved, a more even distribution of freight cars will be the result, the rural community of today will be vastly improved from an industrial, social and economic standpoint. The time has come when we must recognize these facts, and build up our sparsely settled districts and draw some of the urban population into the smaller places. The strength of the nation depends upon such development.

Industrial Development of the Interior

Another point is that the backbone of our country, the Mississippi Valley as well as the Missouri Valley, must be developed with factories, steel mills, foundries and the like so that in event of hostilities with any nation or group of nations, if we were to lose our coast cities, we would still be capable of offering a tremendous defense from drawing our supplies from our inland nation.

Poo poo this danger if you will, but what has occurred in the past may occur in the future, and a chapter of accidents and foreign successes might well place us in a very hazardous corner where all our inland reserves might be called upon to the very limit.

To sum up in a few words, we are as a nation not putting forth our best efforts to draw our foreign population to us and to educate them to the principles of our freedom and to the glory of being wrapped in the folds of the Stars and Stripes.

SNOW REMOVAL IN FARGO, NORTH DAKOTA

To the Editor:

Early in October we had a very heavy snow which practically blocked traffic and stopped business. In considering ways and means to open the streets, we constructed an "A"-shaped snow plow as shown in the accompanying view. This plow is built of 3-in. material with the lower edges lined with steel; it is 2 ft. high with a spread of 16 ft., wide enough to permit two vehicles to pass. Considerable work was accomplished with the snow plow attached to the "caterpillar" tractor.

It was not long until the various organizations throughout this section were taking up the matter of keeping the streets and roads free from snow. The merchants are always very anxious that the necessary steps be taken to keep the highways open to traffic. A number of cities in this section have gone on record recommending that such steps as are necessary be taken to provide such equipment as may be needed to do this class of work.

The State Automobile Association of North Dakota

CATERPILLAR TRACTOR DRAWING HOME-MADE SNOW PLOW AT FARGO, N. DAKOTA.

has gone on record recommending the adoption of some means of keeping the streets and roads clear of snow during the winter. Farmers favor this suggestion because it means they will be less isolated after a snow fall and merchants favor it because of the increase of business it will bring. If automobiles can be kept running all the year the automobile dealers and garages will be able to keep their men employed twelve months in the year, whereas at present it is often necessary to cut down the force because of lack of business.

With good roads comes the necessity of keeping them open for traffic twelve months in the year. It is not expected that we shall invest our money in permanent highways and allow the snow to impede traffic for five months each year.

The snow plow we used was built rather hurriedly, but it did very satisfactory work. We believe that in another season it can be greatly improved upon, and if proper attention is given the roads upon getting our first snow fall we will be able to keep the roads open and in such condition as will permit the traffic to pass in the regular way.

Very truly yours,

H. P. Smith.

Fargo, N. D., April 16, 1920.

WATER WORKS SECTION

METHOD EMPLOYED IN CLOSING A LEAK UNDER A DAM

By W. D. P. Warren, of Miller, Holbrook, Warren & Co., Civil Engineers, Millikin Bldg., Decatur, Ill.

A problem often presented to engineers is that of preventing the destruction of dams, abutments or other similar structures from the undermining action of water.

Singularly enough, little is given in our current journals on this subject, and yet some knowledge along this line will frequently prevent the loss of very important engineering structures.

As a member of the firm of Miller, Holbrook, Warren & Co., Consulting Engineers for the City of Decatur, Illinois, during 1919, the writer was called upon to investigate a leak under the concrete dam in the Sangamon River, near the city pumping station. As the city water supply depended entirely on this structure, it is readily seen that its loss meant a great deal to the 45,000 inhabitants of Decatur.

In this connection, it is interesting to note that the Sangamon River at this point has a water shed area of over 800 square miles, the normal flow having afforded sufficient water during recent years to supply the needs of the city. The concrete dam in the river was originally built about 10 ft. high, 100 ft. long, and served to impound water only in the main channel of the river. At the present time the city has under construction a large dam which will provide an impounding reservoir covering about 4,000 acres.

The concrete dam in the channel of the river was built about 12 years ago, and consists of a gravity section probably 100 ft. long, with wings at each end extending about 2 ft. above the spill-way level, and set at about the elevation of the natural ground in the valley proper, thus permitting the water in flood time to spread over the entire structure as well as the valley.

The concrete dam referred to was built on rather pervious soil, overlying a sand and gravel deposit probably 50 ft. in depth, the dam being supported by piling and solid sheeting being driven into the bed of the river to prevent any underflow.

During the season of 1918, a serious break occurred under the south wing of the dam, and as the sheeting under the main structure did not extend under this wing, the water quickly tore a large opening under the wing, finally undermining it and entirely washing away its outer end. This required the construction of an extension to the spillway section and the construction of a new wing, farther to the south, on solid ground.

At the time of this break in 1918, the writer was not connected with the city, so is unable to give information as to the rapidity with which the wing failed, or to state the manner in which it was undertaken to prevent its destruction, however, the fact that an expense of about $36,000 was incurred because of its destruction is interesting in considering the problem as presented by a somewhat similar occurrence again in 1919.

In July 1919, Mr. Harry Ruthrauff, Water Works Commissioner, requested the writer to accompany him to the site of the dam to investigate a leak which had been reported there. Upon arrival we found a crew of men endeavoring to stop the leak by unloading heavy stones about the place where water was passing under the dam. Also we found about 6 ins. of water passing over the spillway, with water at one point below the dam coming up from under the structure with such force that it threw sand and gravel 1½ ft., or more, above the level of water below the dam. In other words, there appeared to be a powerful current sweeping under the dam, cutting a hole which might at any time cause the entire current of the river to sweep under the structure as it had done during the previous year when the south wing had been undermined.

The leak seemed to be in the vicinity of the old south wing, where the new spillway section joined it. However, as many wooden piling and heavy sheet piling had been left in place after the construction of the previous year, it was very difficult to determine any definite point of leakage.

Upon brief investigation it was learned that sheeting had been driven under the new spillway section, as well as the old one and that upon completing the work the previous season, the opening under the old south wing had been refilled, the filling however, having been placed without putting in sheeting or an impervious wall of any character. Thus, as we later definitely determined, the leak was under the portion of the old south wing still remaining, this wing extending about 10 ft. up stream from its junction with the spillway, and about 15 ft. down stream, offering an opening about 3 ft. wide upon the washing out of the earth filling underneath.

The force with which the sand and gravel were thrown above the water, and the area over which this occurred, probably 10 sq. ft., indicated that the time for prompt action was at hand. Commissioner Ruthrauff, fully appreciating the danger to the structure, advised that he wanted the undivided attention of the writer on this work until the leak was stopped and stated he was ready to furnish any material and labor that we considered necessary.

Having in mind the repair work of the previous season and its cost of $36,000 which had been made a campaign issue in the spring election of 1919, we doubtless created some surprise when we recommended laying a mat of green willow trees about the old south wing, and covering these over with gravel, then sand and clay.

This was essentially the plan followed, and later work on this area so covered, disclosed the fact that at some

Printed as insert to MUNICIPAL AND COUNTY ENGINEERING, Chicago, Ill., September, 1920.

points an absolutely impervious mat had been formed by placing such material to a thickness of less than 2 ft.

The small green willows were cut from the bank at the site of the dam, tied in bundles about 10 ins. in diameter and 6 to 8 ft. long, weighted at each end with heavy stones and sunk about the old wing. Upon this mat which was very hard to spread because of old sheeting, piling, and large rocks already thrown in at this point, gravel ranging in size from 1 to 4 ins. was placed and over this a mixture of sand and gravel, about 80 per cent sand, was then laid. This was covered over with clay having a good percentage of sand, secured in the vicinity of the structure. The fact that leakage was occurring under the full length of the remaining portion of the old wing, both above and below the dam, and that the old piling, rocks, etc., held the willow matting up at places, required the covering of a much larger area than might otherwise have been necessary.

Another difficulty was experienced due to the rise of the water in the river, requiring the transporting of all materials from the banks in a cumbersome flat boat.

After several days enough material had been placed to form a coffer dam above the spillway and about the old wing, and by gradually taking out the large stones, some of which were 1 ft. to 2 ft. in length, the impervious material had been worked down sufficiently under the old wing to reduce the underflow greatly.

The sand and water, however, continued to rise about the portion of the wing below the spillway, indicating that there was not sufficient material of proper size getting under the wing to close the opening. This condition suggested a plan of placing the willow mat over the entire area about the down stream end of the old wing, and covering it with heavy stones. Accordingly this was done, resulting in the decreased loss of material which had been passing away under the old wing from the up stream side.

In doing this work, it was borne in mind that there had been a mine subsidence in this area due to removal of the coal at a depth of over 600 ft. and that settlement might occur in the future disturbing any rigid construction, also that if the dam could be maintained for a period of several years, the new impounding reservoir would then be complete.

The work outlined above required several hundred cubic yards of material and a force of five to 10 men over a period of a week or more, but it was considered necessary to place sufficient material above the spillway and about the old wing so that it would gradually settle into the opening and thoroughly close it, being stopped by the placing of the mat on the down stream side.

Before leaving the work, it was finally found that the material placed above the dam was sufficiently solid to act as a coffer dam, and men were then set to work to go down to the opening under the old wing at its intersection with the spillway section, taking out the gravel, sand and willows and finally removing the large stones which had thoroughly prevented the willows from getting into the real opening under the wing. This opening was then carefully sealed and the material replaced, all material above the spillway and about the wing being then covered over with a course of heavy stone to prevent its being carried out during flood time.

The mat below the spillway, covered with heavy stones, serves to check all fine material working through from the upstream side.

The plan followed in this work was approved by Mr. F. D. Holbrook of our firm, who has spent many years in charge of lock and dam construction on the Ohio River. Mr. Holbrook has found the use of willows very effective is stopping leaks in coffer dams and other structures.

In choosing materials to place over the willow matting, consideration should be given to the proportions generally specified for puddle wall construction.

Col. John T. Fanning, M. Am. Soc. C. E., recommends the following proportions: 0.2 cu. yds. of clay, 0.15 yd. of sand, 0.33 yd. of fine gravel, and 1.00 cu. yd. of coarse gravel. The value of using fine material on the upstream side is readily understood, as such material tends to silt all small openings rapidly between the sand and gravel particles, and form an impervious wall.

The method followed in closing the leak under the dam at Decatur secured the desired result and the cost of the work was extremely small considering the cost of the previous season and the importance of the structure.

The plan of using inexpensive materials, available at the site of the structure involves the employment of nature's own resources for the benefit of mankind, and for this reason should be worthy of consideration.

INCREASING ECONOMY OF ST. LOUIS WATER WORKS PUMPING PLANTS

By Leonard A. Day, Engineer in Charge, Operating Section, Water Division, 34 E. Grand Ave., St. Louis, Mo.

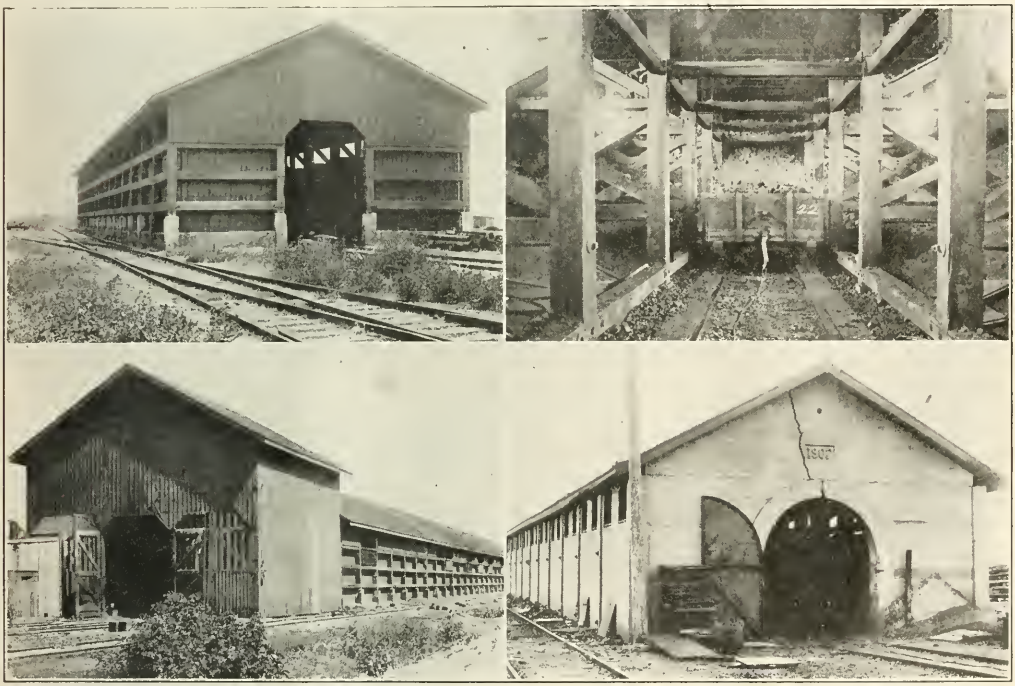
Inasmuch as the economy of pumping stations from a heat saving standpoint deals directly with coal, and owing to the rapid increase in cost of coal throughout the country, it became imperative on the part of the engineers of the St. Louis water department to make a thorough investigation of the heat losses existing in the respective plants with a view to reducing the losses to the lowest possible minimum. When it is considered the coal cost constitutes probably 40 per cent. of the total pumping cost and that in the average pumping plants throughout the country not more than 10 per cent. of the heat value in coal is utilized, it is easy to see that the more economical use of coal is highly profitable.

Storing Coal

In passing it would be well to mention our experience in storing coal. We have found that practically all grades of bituminous coal can be stored for an indefinite period without any material loss in its heat value, if proper precautions are taken in storing it. The Water Department of the City of St. Louis is provided with storage capacity of 15,400 tons, which will maintain a supply sufficient to last over a period of 60 days. Notwithstanding the fact that we are in close proximity to the Illinois coal fields, the wisdom on the part of the Department in maintaining this liberal supply for emergency use has manifested itself on several occasions since the beginning of the war.

The coal stored is known as 6-in. screened lump. It is piled 16 to 18 ft. high in sheds. Heat value determinations have been made on this coal after having been in storage for a period of 10 years, the results of which show no appreciable heat loss due to storing. Naturally

coal loses some of its moisture and this loss tends to compensate for the heat loss due to some of the volatile gases being set free. We do not attempt to store Illinois screenings for any length of time. We have, however, stored 2-in. Illinois screenings for one year, containing about 45 per cent. by weight of Duff. By Duff is meant coal that will pass through a screen having circular perforations ¼-in. in diameter. This coal showed no signs of heating and was placed in a pile about 6 ft. high in the open air with no protection from rain or snow. In general it has been our experience that all bituminous coal free from fines or Duff can be stored for an indefinite period without appreciable heat loss, it being preferable to store sized



VIEWS OF COAL STORAGE SHEDS OF ST. LOUIS WATER WORKS.
Top Row: Fig. 1—Chain of Rocks Shed. Fig. 2—Typical Interior of Coal Storage Sheds. Bottom Row: Fig. 3—Coal Storage Shed at Baden Station. Fig. 4—Shed at Bissell's Point Station.

lump coal and in storing it the coal should be placed with the idea of minimizing breakage.

Chain Grate Stoker

Returning to the consideration of the economical use of coals. According to our experience, the chain grate type of stoker is best suited for burning the low-grade clinkering coals, such as is found in the Illinois coal fields within a radius of 25 miles from St. Louis. This type of stoker is capable of meeting any peak load up to 100 per cent. above normal boiler rating. It is simple in construction, easy to repair, it can be operated under all load conditions with natural draft, thereby greatly simplifying the boiler room equipment, and can be operated efficiently on light loads and overloads. Its first cost is about half of that of the forced draft underfeed type. A ratio of 1 sq. ft. of grate surface to 48 sq. ft. of boiler heating surface has given the best results, considering our loads and coals.

Furnace Arch and Combustion Chamber

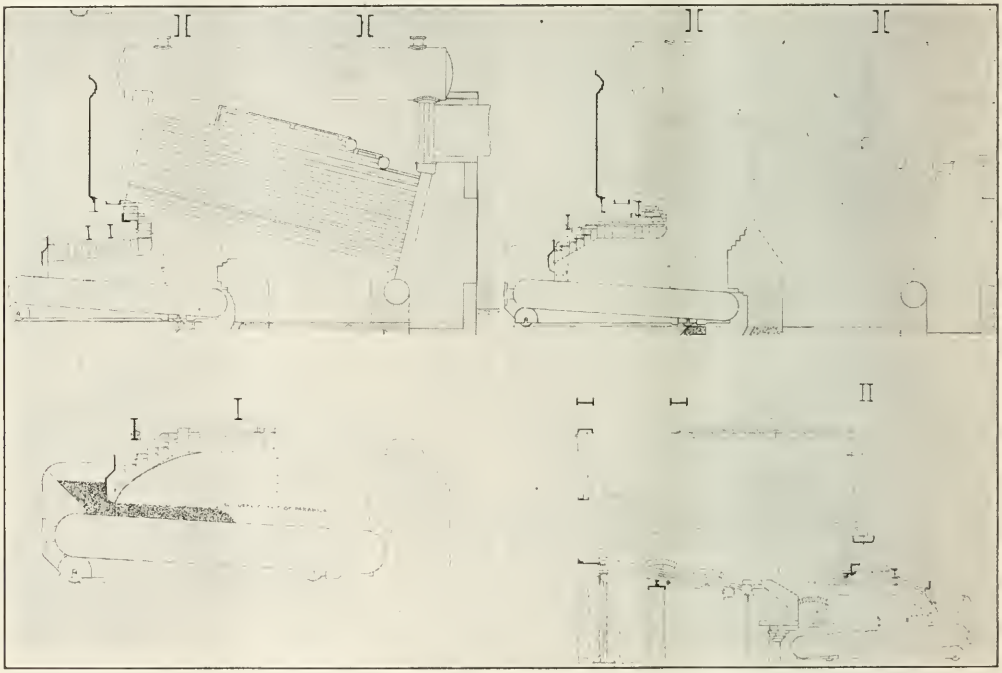
The coal is 2-in. Southern Illinois screenings, having an average heat value of 10300 B. T. U., with from 20 to 25 per cent. ash. In addition to the proper size grate our experience shows that a properly designed furnace arch and a combustion chamber with sufficient volume to allow complete combustion will add greatly to the efficiency and capacity of the boilers. The first chain grate stokers we installed were at the Chain of Rocks plant in 1914. The stokers were placed under 6 National Water tube boilers, each of 300 H. P., and two O'Brien Water tube boilers, each of 250 H. P. capacity. The boilers were set 7 ft. from the floor, and the arches were set 11 ins. from the grate at the front and 22 ins. from the grate at the rear, the arch being 6 ft. 5 ins. long. The original arch was set according to the designs of the stoker contractor. The boilers were arranged with horizontal baffles, the lower baffle being placed on the second row of tubes. The average boiler efficiency under operating conditions with this setting was approximately 58 per cent. and it was difficult to obtain an overload of 25 percent. Investigations were started at this station with a view of increasing the boiler efficiency and capacity. We have found that a stoker arch to function properly should be set high enough over the grate to allow the volatile gases to be distilled off without being crowded under the arch, also the shape of the arch should be such as to allow the heat from the bridge wall to be focused on the coal as it enters the

furnace; this is necessary to start combustion in as short a time after the coal leaves the feed gate as possible so that every available foot of grate surface is utilized for burning coal. By referring to Fig. 5, which shows the original arch, it will be apparent, that from the standpoint of obtaining a large liberating volume under the arch and an efficient shape of the roof so as to obtain the maximum benefits of heat reflection coming from the bridge wall, that this arch did not function properly.

Referring to the lines indicating heat rays, it will be observed that this arch does not permit a concentration of heat at a point where a maximum concentration is desired, namely, at the point of ignition. These objectionable features have been overcome by the new design of arch shown on Fig. 6.

With the old type arch on a capacity test run by the stoker contractor, an evaporation of 15,770 lbs. of steam per hour was maintained for ten hours. With the new style arch an evaporation of 17,140 lbs. of steam per hour was generated for five hours. The former represents an overload of 38 per cent., while the latter represents an overload of 60 per cent. At the same time the average boiler efficiency was increased from 58 per cent. to 63 per cent., or a gain in efficiency of approximately 9 per cent. After all boilers will have been equipped with the new arch, it is estimated that the saving in annual coal cost will amount to about $5,000 at this station.

A similar improvement in capacity and efficiency was made at the Bissell's Point Station. The boilers at this station are set with the front water leg 6½ ft. above the



SOME OLD AND NEW BOILER SETTINGS OF THE ST. LOUIS WATER WORKS. TOP ROW: FIG. 5—CROSS SECTION THROUGH OLD CHAIN OF ROCKS BOILER SETTING. FIG. 6—NEW CHAIN OF ROCKS BOILER SETTING. BOTTOM ROW: FIG. 7—PARABOLA SUPERIMPOSED ON NEW ARCH; FIG. 8—CROSS SECTION THROUGH BADEN BOILER SETTING.

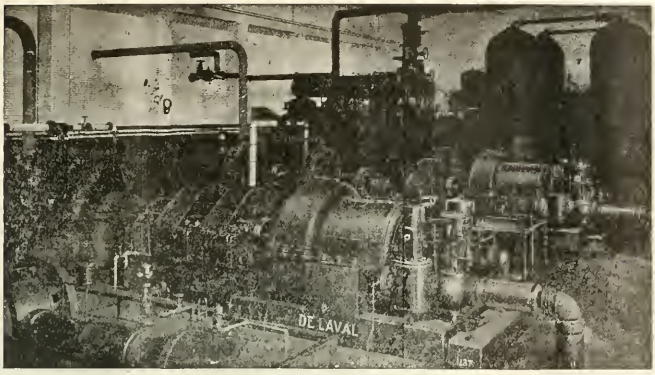
In this setting, the distance from the floor to the front water leg remains 7 ft., being determined by the original setting of the boiler. The arches are set 12 ins. from the grate at the front end, rise rapidly to a hip, and are 36 ins. high at the rear. The length of the arch is 6½ ft.

This arch has a better concentration of heat rays near the feed gate, the rays being reflected from the bridge wall, than the one shown in Fig. 5, due to our obtaining a contour which approximates the curve of a parabola, in which curve all reflected heat rays would concentrate at the focus. To illustrate, Fig. 7 shows a parabolic curve superimposed on the improved arch.

Effect of Arch Shape

Comparative tests made before and after the change in the arch shape resulted in the following:

floor line. The original arches were sprung transversely across the grate 9 ins. above the grate at the hip, rising to 18 ins. above the grate at the center. Longitudinally the arch was parallel to the grate. This type of arch, that is, in respect to the low height above the grate, was the common practice among chain grate stoker builders up to within but a few years past. The arch was removed and replaced with a new type of flat arch, which is 12 to 13 ins. above the grate at the feed gate, and rises straight, without a hip, to 30 ins. above the grate at the rear end. The length is 7 ft. It was not possible to construct a hipped arch at this station because of the limitation of the low setting. However, a good saving was effected for the reason that prior to the change in arch design, it was only possible to burn crushed egg or lump coal at this station, due to the low arches, which did not affect the proper



Two De Laval geared turbine-driven pumping units installed for the City of Philadelphia, each rated at 22,000,000 gal. per day, 355 head.

De Laval Geared Turbine-Driven Centrifugal Pumps at Philadelphia

The history of De Laval Steam-turbine-driven Centrifugal Pumps in Philadelphia is representative of the progress which De Laval pumps are making in water-works plants throughout the country.

In 1909, the City of Philadelphia placed a contract for a De Laval steam-turbine-driven centrifugal pump to deliver 50,000,000 gal. per day against a total head of 50 ft. This pump raises water from the Delaware River to the Torresdale Filtration Plant.

Subsequently, two De Laval steam-turbine-driven units, each of 22,000,000 gal. per day capacity against 335 ft. head, were placed in operation at the Belmont Pumping Station.

At the Lardner's Point Station, a De Laval geared steam-turbine-driven pump of 35,000,000 gal. per day capacity against 201 ft. head has been installed.

At the Queen Lane Station a unit consisting of a De Laval turbine driving two 24 in. centrifugal pumps in series is used to deliver 25,000,000 gal. per day against 279 ft. head.

Recently orders have been placed for four De Laval geared turbine-driven centrifugal pumps of a normal capacity of 40,000,000 gal. per day each against a total head of 275 ft. to be installed in the Queen Lane Station. These are probably the largest capacity water-works pumping units ever constructed and will replace 4 triple-expansion reciprocating pumping engines. These pumping units will have a maximum capacity of 48,000,000 gal. per day each.

The reasons for the unparalleled success of De Laval Geared-Steam-Turbine-Driven Centrifugal Pumps in water-works service, are, first, their reliability and, second, their unequaled overall economy.

They pump water at the least cost, when all costs, including fuel, labor, supplies and capital charges, are taken into account.

Our special Water Works Book tells how water-works pumping problems have been solved in numerous cities throughout the United States and Canada. We would gladly send you a copy upon request. Ask for Catalog W67.

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DE LAVAL STEAM TURBINE CO.

TRENTON, NEW JERSEY

ignition with the lower grades of screenings. The new designed arch has resulted in our being able to burn the lower grades of screenings successfully, and obtain the same evaporation per pound of coal with screenings as with the crushed egg and lump coals, thereby resulting in a saving in the price of coal of about 18 per cent. This 18 per cent. saving in the price of coal when applied to our last year's coal cost at this station, amounts to an annual saving in coal cost of about $10,000. Also after all the boilers at this station were equipped with the new type arch, the average overall rating of the boiler room rose from 90 to 115 per cent., even with the use of a lower grade of coal.

Although we realized after the new arch was designed, that the setting was not perfect, the boilers being too low, yet even with the low setting the arch has given the tion averages 6½ lbs. of water per pound of coal at a boiler room efficiency of 66 per cent. and comparing this performance with that of the other stations when the old type of settings prevailed shows a saving of about 13.8 per cent. in coal.

Results of Rebuilding the Arches

As has been previously stated, the overall boiler efficiency of the other two stations is 63 per cent. with the improved arch, while that at the Baden station, with practically the same style arch as was adopted at the other stations, shows an overall boiler efficiency of 66 per cent. This increase of 3 per cent. in efficiency or a gain of 4.8 per cent. may be attributed to the higher boiler setting, namely, 9 ft. instead of 7 ft., which prevails at the other two stations. In other words, by our setting the boilers 2 ft. higher at the Baden station we show a gain

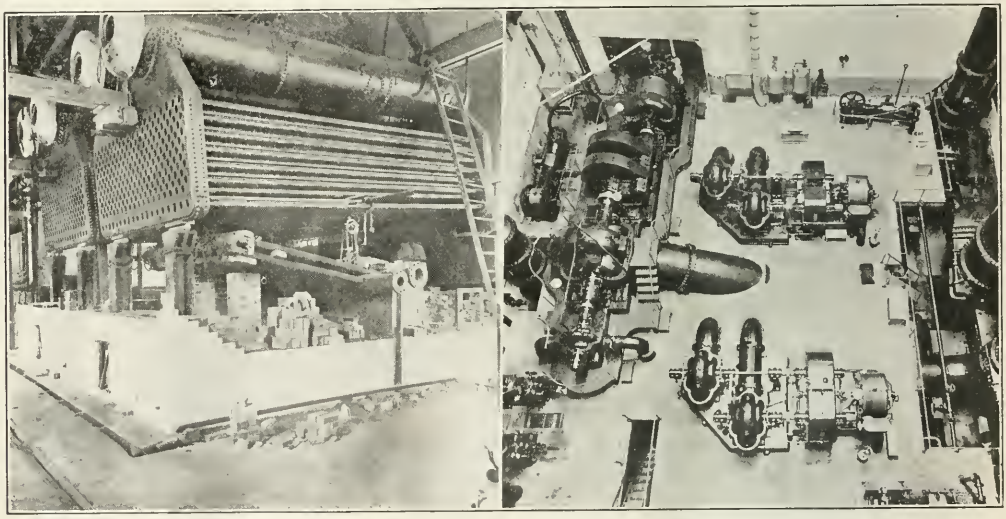


FIG. 9—BOILER SETTING, BADEN STATION, SHOWING SUPER-HEATERS IN COMBUSTION CHAMBER. FIG. 12—STEAM TURBINE DRIVEN CENTRIFUGAL PUMPS IN MIDDLE PIT, CHAIN OF ROCKS STATION, ST. LOUIS WATER WORKS.

improvement in capacity and efficiency mentioned above, permitting one boiler to be taken off of the line.

Elimination of Objectionable Features

The results of experience with the two installations from the standpoint of their objectionable features as previously outlined, led us to adopt in the installation of new boilers at the Baden plant, a setting in which we have embodied a construction which we believe eliminates all objectionable features found by previous experience.

Fig. 8 shows a cross section through the boiler setting. In this setting the arch is similar to that of the new arch for the Chain of Rocks Station, the distance at the feed gate above the grate is 10 ins., rising rapidly to a hip, and is 34 ins. above the grate at the rear. The length of the arch is 7 ft. The height of the front water leg above the floor is 9 ft., this height providing a larger combustion chamber than in the previous settings, thereby obtaining a more thorough mixing of the gases and oxygen and providing a relatively longer gas travel, all of which is necessary for the efficient burning of coal at high rates of combustion. The evaporation at this station of 4.8 per cent. in overall boiler efficiency, and this gain when computed on an annual cost of coal at this station amounts to $3,000 annually.

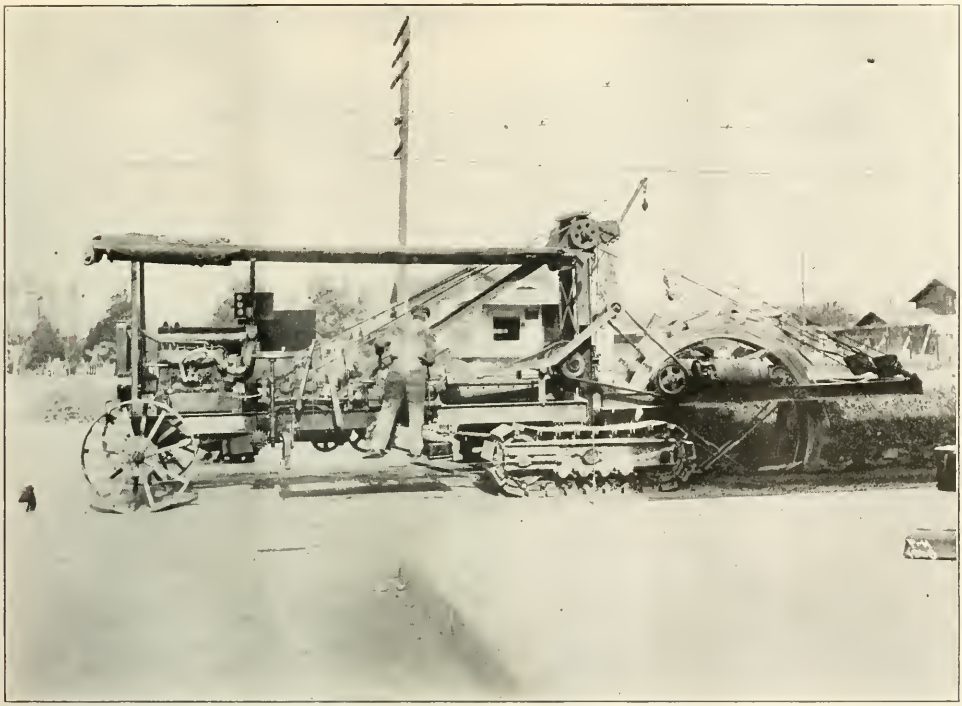
An operating overall boiler room efficiency of 66 per cent. using Southern Illinois screenings, of 10300 B. T. U. per pound, and meeting a variable daily load, may be considered as good as can be expected from this type of boiler room installation.

Our actual cost of rebuilding the arches at the Chain of Rocks and Bissell's Point stations amounted to about $300 per arch, or a total of $4,200, while the saving in coal effected due to these changes amounts to approximately $15,000 per year. The entire work of rebuilding the arches was paid for in 3½ months.

These gains are principally due to the improvement in furnace design, but part of the saving in coal must be credited to improvements made in our boiler baffling.

Improvements in Boiler Baffling

Boiler baffling should be so placed as to force the gases into contact with all parts of the tube bank. In the older Heine type of settings of our plants the lower



Wheel Type P & H Excavator Cutting a Pipe Line Trench.

Pipe Line and Conduit Trenching

THE WHEEL Type P & H Excavator is especially adapted to pipe-line, telephone or wire conduit, and gas main excavation. Its comparatively light weight (the No. 122 K C weighs 19,500 lbs.) permits its use where the land is rough or swampy; its width (10 ft. 7 ins.) is not such as to block a road; and it operates on a convenient form of fuel—gasoline, kerosene, or distillate. Built in four sizes, according to depth and width of trench.

This machine will cut trenches from 15 to 28 ins. wide and from 54 to 90 ins. deep, and the trench may be either straight or curved.

Cost of trenching is reduced to the lowest point, as this is a truly one-man machine.

Whether the work is the average easy job, or one calling for exceptional excavator strength, this Wheel Type P & H Excavator will work rapidly. It has established performance records that has won leadership for quick, cheap and accurate trenching in any kind of material in which an excavator can be operated.

All necessary adjustments are quickly made, for this excavator is especially designed (and perfected under severe conditions) to cut pipe line and conduit trenches.

Ask for Descriptive Bulletin IX.

Pawling & Harnischfeger Co.

EST. 1884

MILWAUKEE, WISCONSIN

Church Street, New York
Stephen Gerard Building, Philadelphia
Whitney Central Building, New Orleans, La.
Fidelity Building, Pittsburgh, Pa.
Monadnock Block, Chicago, Ill.
Yeon Bldg., Portland, Oregon
Central Building, Los Angeles
Monadnock Bldg., San Francisco
L. C. Smith Building, Seattle, Wash.

"You see them wherever you go, and they go wherever you see them."

P&H — excavators — back-fillers - tampers

baffle was made up of box tile on the lower row of tubes and the upper baffle was 13 tubes above on the top row of tubes. The opening in the lower baffle was in some cases as much as 60 ins. from the rear water leg. The path of the gases in this type of boiler was diagonally upward through the tubes, leaving the rear water leg and the tube ends near it untouched by the hottest gases, and leaving a dead triangular pocket at the bottom of the front water leg.

By eliminating the box tile on the lower row of tubes and placing a specially designed tile on the third row of tubes, and also reducing the opening in the lower baffle from 60 ins. to 42 ins., we reduced the flue temperature from an average of 650 degrees F. to 550 degrees F.

It will be apparent from Fig. 8 that the velocity of the gases is higher through the tubes, thereby reducing the insulating effect of the film of idle gas around the tubes and resulting in a better heat absorption. It will also be apparent that the bottom rows of tubes are now exposed to the radiant heat of the flames; thus by raising the baffle tile onto the third row of tubes the gases are crowded into more intimate contact with the tubes, dead pockets in the passes are destroyed, and the lower row of tubes, by absorbing the radiant heat of the flames, tend to lower the temperature of the surrounding walls of the combustion chamber, which in turn tends to increase the life of the setting.

When it is remembered that roughly there is a gain of 1 per cent. in boiler efficiency for every 25 degrees F. reduction in flue temperature, it will be seen that there was an approximate gain of 4 per cent. in efficiency for the 100 degrees F. drop just mentioned, a gain effected by merely placing the boiler baffling into a better location and at a negligibly small cost.

Simultaneously with the installation of chain grate stokers, superheaters were installed in our boiler settings. For determining the size of superheaters, accurate gas temperatures were taken at the place where the superheaters were to be located, and the steam load and firing conditions noted simultaneously as an aid to the manufacturer of the superheater arriving at its proper size.

In the case of horizontally baffled boilers, our superheaters are located in the combustion chambers back of the bridge wall, and in the vertically baffled boilers, the superheaters are located under the shell between the first and second pass. Although the location behind the bridge wall is apparently a severe location, yet it has been our experience that if the superheaters are not within the direct path of the flame, they show no effects of the heat, and promise a long life. The advantages of the location in the combustion chamber, are, a smaller superheater and greater accessibility.

Use of Superheated Steam

The use of superheated steam at all of our plants has proven to be one of the greatest factors in increasing the efficiency of the engine rooms.

Superheated steam in the cylinder of a steam engine transfers heat to the cylinder walls, but instead of condensation occurring on contact as with saturated steam, the superheat must first be withdrawn. Superheated steam maintains a higher cylinder wall temperature and if superheating is carried far enough, condensation can be delayed until after cut-off and even until expansion is partly completed. Also the specific volume of superheated steam is greater than that of saturated steam and this increase in specific volume, the pressure being constant, diminishes the weight of steam to the engine and has an influence on the economy gain, as has also the lower thermal conductivity of superheated in comparison with saturated steam.

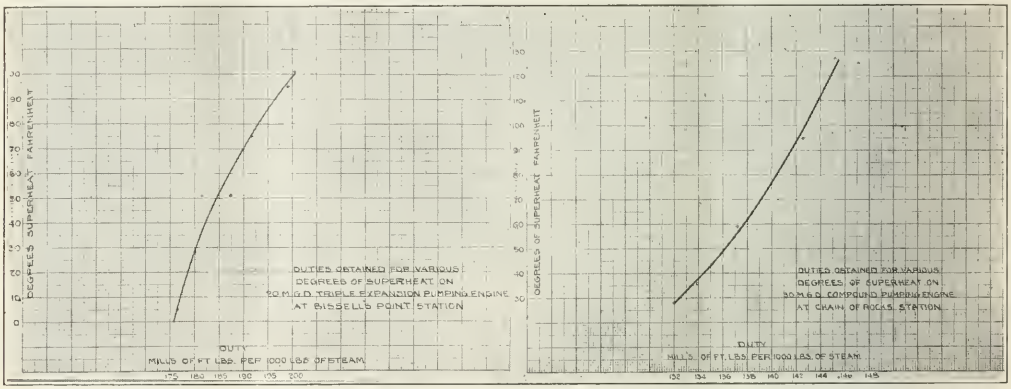

DEGREES SUPERHEAT FAHRENHEIT
DUTIES OBTAINED FOR VARIOUS DEGREES OF SUPERHEAT ON 20 M.G.D. TRIPLE EXPANSION PUMPING ENGINE AT BISSELL'S POINT STATION
DUTY
MILLS OF FT. LBS. PER 1000 LBS. OF STEAM
DEGREES OF SUPERHEAT FAHRENHEIT
DUTIES OBTAINED FOR VARIOUS DEGREES OF SUPERHEAT ON 30 M.G.D. COMPOUND PUMPING ENGINE AT CHAIN OF ROCKS STATION
DUTY
MILLS OF FT. LBS. PER 1000 LBS. OF STEAM

FIG. 10—DUTIES OBTAINED FOR VARIOUS DEGREES OF SUPERHEAT OVER 20 M. G. D. TRIPLE EXPANSION PUMPING ENGINE AT BISSELL'S POINT STATION. FIG. 11—DUTIES OBTAINED FOR VARIOUS DEGREES OF SUPERHEAT ON 30 M. G. D. COMPOUND PUMPING ENGINE AT CHAIN OF ROCKS STATION.

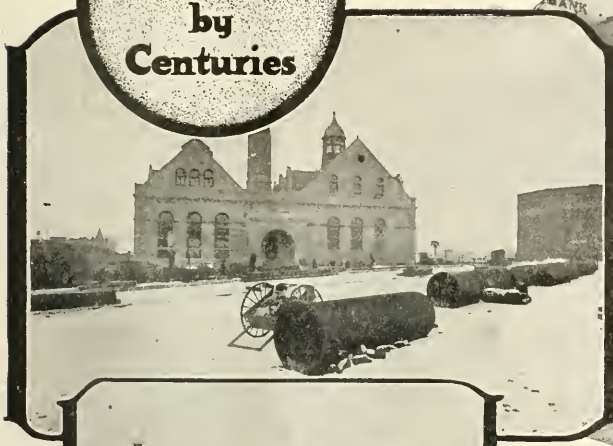
The Water Division has made tests on the effects of superheated steam on triple expansion and on compound pumping engines. The triple expansion engines, which pump against a head of 85 to 125 lbs. pressure and whose capacities vary from 15 to 20 M. G. D., showed a saving for various degrees of superheat as shown in Fig. 10.

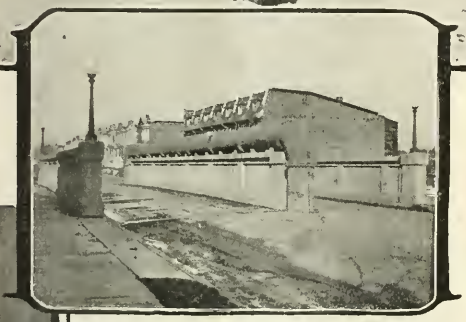
The steam saving for 100 degrees superheat amounted to 12.1 per cent., while the saving in coal amounted to 7.5 per cent.

The compound pumping engines, which pump against a maximum head of 65 ft. or about 28 lbs. pressure, and whose nominal capacity is 30 M. G. D., showed a saving for various degrees of superheat as shown in Fig. 11.

The steam saving for 100 degrees superheat amounted to 17.3 per cent., while the saving in coal amounted to 14.1 per cent. The saving in coal due to the introduction

Service Measured by Centuries





115 Years Service in the Monumental City

BALTIMORE has reason to be proud of her water systems, both in the city proper and annexed territory. Practically all of the 1550, or more, miles of pipe now in use (except some high pressure mains) is Cast Iron, the first installation dating back to 1805.

A recent report of the National Board of Fire Underwriters on the Baltimore water supply says—"Repairs have been made to the * * * portion of the * * * conduit which have reduced the leakage considerably, but it is reported that during the winter leakage still continues."

The portion of conduit referred to, is *not* Cast Iron.

Handsome cloth bound book—"Pipe and The Public Welfare" sent on request

The Cast Iron Pipe Publicity Bureau
1 BROADWAY, NEW YORK

CAST IRON PIPE

of superheated steam into our Chain of Rocks Station has been sufficient to pay for the superheaters in about 3½ years. The life of a superheater when the elements are not exposed to the direct flame, should be equal to the life of the boilers.

It is commonly accepted that the degree of superheat for the usual equipment of engines and pumps is limited by a total temperature of 500 degrees F., especially when using cast iron fittings. The Department has resorted to the use of cast steel fittings and valves on all new pipe work. At the time we installed the new pipe work, it was done not solely with the idea in view of meeting the total temperatures of the superheated steam which we intended to use, but also to insure more reliable service in all of our pipe lines than cast iron fittings and valves would give. We have, however, in one of our plants still in use, the original extra heavy cast iron fittings made by a reputable manufacturer which have given excellent service with a total temperature of as high as 500 degrees F. These fittings have been in service some 5 years under superheated steam conditions without showing any apparent signs of weakness.

While speaking of steam piping, it may be added in additional favor of superheat (to quote) that "due to the absence of moisture, superheated steam offers less friction passing through pipes than saturated steam, therefore, the speed of travel can be higher and the piping, fittings and valves smaller. When piping is designed especially for superheated steam, the reduction in size will go far towards paying for the superheaters. Where it is turned into an existing system of piping, the radiation may be some greater than if the piping were of proper size, but the reduction in pressure would be less. The actual radiation from superheated steam, under similar conditions, is less than it is with saturated steam, because, even though the temperature is higher, its low conductivity makes it lose heat less rapidly. Besides, the pipes are not so wet and hence have less conductivity. Depending on the steam speed and the pipe protection, superheated steam is figured to lose one degree of superheat in from 6 to 10 ft. of travel."

Effect of Superheat on Compound Pumping Engine

Reverting again to the tests made on the compound pumping engine to determine the effect of superheat. The pumping engine when it was originally installed, 25 years ago, developed a duty of 118 million foot pounds per 1,000 lbs. of saturated steam, no superheat being used at this time. The pumping engines at this station were all bought on the bonus and forfeiture basis, which naturally led the contractor to make every effort toward obtaining the very highest duty possible. The Department, however, in running the duty tests with variable degrees of superheat, made no attempt whatever to increase the economy of the pumping unit before the test was run, by increasing the vacuum, repacking the plungers, renewing pump valves, inspecting valves and pistons, and so forth. In other words, the test was run on a pump running under every day plant conditions, and even with a superheat of only 28 degrees, which is the lowest we could obtain, the pump developed a duty of 132 million foot pounds per 1,000 lbs. of steam, which is a saving of 11.9 per cent. in steam consumption over that of the original duty test with saturated steam, where the duty obtained was 118 million foot pounds per 1,000 lbs. of steam. This is a very creditable showing for a pump that has been in service for 25 years.

As we previously mentioned we expected a better saving by the use of superheated steam on our compound low service pumping engines than on the high service triple expansion engines, for the reason that a compound pumping engine of the usual cylinder proportions is not as economical as a triple expansion pumping engine, due to a greater heat drop in each cylinder, causing a greater cylinder condensation, and as superheated steam specifically functions to prevent cylinder condensation, it follows that its greatest virtue will be manifested in the less economical engine.

Handling Lubrication

There seems to be, to the writer's knowledge, a prevailing impression in a great many water works plants, that the use of superheated steam with its consequent economies is offset by difficulties with lubrication. This contention is not borne out by the experience of our Department.

For a short period, a straight mineral oil with no tallow was used as cylinder oil with superheated steam, but was found to be unsatisfactory. It was found that the compounding with tallow was necessary.

In lubricating engines using superheated steam, the only parts which actually come into continuous contact with superheated steam are the inlet valves on the high pressure cylinder, for all other parts of the engine beyond this point, cylinder and piston, are at a mean temperature lower than the steam temperature entering, due to the fact that steam with even 100 degrees F. superheat becomes saturated by the time the piston travels to the point of cut-off in the high pressure cylinder. We found that our lubricating problems were, therefore, no more difficult with superheated steam than with saturated steam. Our cylinder oil possesses the following characteristics, to quote our specifications:

Cylinder Oil Characteristics

Cylinder oil shall be a compound oil of 2 per cent. pure acidless tallow oil, and 98 per cent. pure filtered mineral oil. It must be free from dirt, grit, lumps and specks; transparent amber in thin film; bright ruby through neck of 4-oz. bottle; translucent greenish by reflected light. It must satisfactorily pass the following tests:

Specific Gravity—26° to 28° Beaume at 60° F.
Flash Point—Must not flash below 540° F.
Burning Point—Must not burn below 600° F.
Viscosity—Must not be less than 130 Saybolt at 212° F.
Cold Test—Must flow readily at 50° F.
Water—Must not froth or bump when heated in flash cup.
Tarry and Suspended Matter—5 ccm of this oil shaken with 95 ccm of 88° petroleum ether in a glass stoppered graduate must show no precipitation of tarry and suspended matter.
Volatility—Heated for 2 hours at a temperature of 400° F. this oil must not show a loss of more than 5 per cent. by weight.
Saponification—When oil is treated with alcoholic potash it must show a presence of 2 per cent. tallow oil.
Quality Test—Heated slowly over an open flame until vapors appear above the oil surface. Maintained at this temperature for 15 minutes. Oil must remain perfectly clear and free from sediment, after standing for 24 hours.

Effect of Superheated Steam on Turbine Driven Centrifugal Pumps

We will now consider the comparisons of the performances of steam turbine driven centrifugal pumps, with and without the use of superheated steam.

Our turbine driven pumps are installed in the same station with the low service compound pumping engines previously referred to. Two of these are of the single stage centrifugal type, each of a nominal capacity of 35 million gallons of water a day. They were installed in the year 1913, and have been in active service ever since. The test duties of these pumps, at a head of 65 ft. was 100 million foot pounds per 1,000 lbs. of saturated steam.

A recent test run under the same pumping conditions, but with 124 degrees of superheat instead of saturated steam, showed a duty of 115 million foot pounds per 1,000 lbs. of steam, an increase in duty of 15 per cent. The physical condition of the pump may be said to have been the same as when the test was run on superheated steam as on the original test with saturated steam for the reason that the unit had just been overhauled; a new steam wheel was installed, the nozzles were rebored and new pump impeller wearing rings were installed.

On the same turbine driven centrifugal pump, comparative tests were made to determine the difference in duty, with the same superheat and vacuum, before and after the pump was overhauled as just described. The duty before overhauling was 93.5 million foot pounds per 1,000 lbs. of steam. The duty after overhauling was 106 million foot pounds per 1,000 lbs. of steam, showing a saving of 13.3 per cent., due entirely to overhauling.

It might be well to mention that the pumps at our low service station are subject to abnormal wear due to their pumping raw river water containing a great deal of sand in suspension.

In conclusion it is hoped that the results of our experiences herein mentioned will serve as a guide to water works engineers in general in their efforts to reduce their pumping station losses to the lowest possible minimum as a means of partly meeting the present increased costs of coal, labor and materials.

The foregoing paper by Mr. Day was presented at the 1920 annual convention of the American Water Works Association.

SEWAGE TREATMENT TO PROTECT WATER SUPPLIES

By Harry B. Hommon, Associate Sanitary Engineer, U. S. Public Health Service, Cincinnati, Ohio

It is common practice for a city to take its water from a river at the upstream side and discharge it below the city as sewage. This dual use of a water-course has been accepted and recognized by the courts as coming within the rights of the riparian proprietor but only in so far as the privileges claimed do not conflict with similar rights of others located on the same body of water.

It is not always an easy matter, however, to decide where the rights of one party end and the lawful privileges of another begin. In the past, and to a certain extent at the present time, courts have been called upon to decide controversies arising from the use of streams

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as a means of disposing of sewage and other wastes. More recently many states passed laws to regulate stream pollution and the results have been so satisfactory that it is believed that within a few years all the states will have laws on their statute books which will permit active control over the purity of the water-courses in the country within the boundaries of the states.

Fundamental Principles Recognized by the Courts

One of the most important results that has come from the court decisions handed down, and the state laws that have been passed in relation to stream pollution, has been the treatment of sewage as a means of protecting water supplies. It may be of interest in this connection to quote the fundamental principles given by Montgomery and Phelps, which the courts have recognized as the basis for their decisions.

> The basic rule in common law has been stated to be that each riparian proprietor has the right to have the stream come down to him with its quality unimpaired and with its quantity undiminished.
>
> But expressions like the above are extreme statements of the rule and cannot be accepted literally.
>
> That is to say, each riparian proprietor is interested on the one hand, in having the water come down to him in its natural state and in its full volume. On the other hand, he is interested in making the largest use of the stream which his convenience or interest may dictate; and since almost any use of the stream has some tendency either to diminish the volume or lessen its purity, or both, it follows that a rule which would preclude each riparian owner from polluting the stream at all or from diminishing its volume at all would defeat its own purpose; and this has been recognized by the courts.

Quoting further from the report referred to above, it is shown that municipalities have no further rights than individuals.

> By the great weight of authority, municipalities have not greater rights than individuals to pollute water-courses and must respond in damages for any injury caused to a lower riparian proprietor and may be enjoined continuing the pollution.

It is thus seen that the courts have recognized the right of an individual, corporation, or city to use a water-course as a means of carrying off its sewage but only to such an extent that riparian proprietors lower down on the same stream will not be deprived of the natural rights accruing from their vested property rights.

If the water in the rivers and lakes of the thickly settled portions of the country were used only for such purposes as the courts and state laws have held as coming within the riparian proprietory rights, it is doubtful whether these sources would furnish a water satisfactory for domestic purposes without some degree of treatment. Even water supplies obtained from protected watersheds located in the hills, mountains, or on the headwaters of streams are often sterilized to guard against accidental pollution.

In considering, therefore, the protection of water supplies by sewage treatment the important problem is not so much as to whether any given water requires purification but rather what effect the presence of sewage in unusual amounts will have on the process of treatment and the character of the water produced. The term sewage is used in the broader sense to include all liquid wastes discharged either from a city's sewers or through outlets from manufacturing plants outside the city limits.

Chief Factors to Be Considered

Using the broader meaning of the word sewage, it becomes apparent at once that a city must consider many factors when deciding whether any given stream that contains a large amount of untreated liquid wastes from other communities is a suitable source for a domestic water supply. These factors will be discussed from the standpoint of the relation they bear to the operation of a purification plant and the quality of water produced.

(1.) The bacterial content of the water. A stream containing comparatively fresh sewage in large amounts will have large numbrs of pathogenic organisms and the potential danger of using such a water, even though filtered and sterilized, may be justification for rejecting the supply or cause for requiring cities or towns upstream to treat their sewage.

(2.) Color. River or lake waters may contain sewage and colored industrial waste to such an extent that the ordinary purification processes will not remove the color. Dye wastes, tannery, and sulphite wastes from paper manufacturing plants are often discharged into streams in large volumes and the color imparted to the water persists for long distances.

(3.) Alkalinity. The normal hardness of river water may be so increased by the presence of sewage and industrial wastes that softening processes will be required; or spent acids may be discharged into a river in sufficient amounts to reduce the alkalinity so that, where coagulation is necessary, an additional amount of chemicals will have to be added.

(4.) Odors and Tastes. River water may have pronounced odors and tastes due to the presence of some industrial wastes. Those from gas manufacturing and oil refineries are the most common.

(5.) Temperature. Industrial establishments located on small streams may use a large part of the stream flow for cooling and other industrial purposes and thereby raise the temperature of the water of the entire stream. The writer is familiar with one case where the water at the intake of a filtration plant has a temperature of 137 degrees Fahrenheit in the summer time.

(6.) The Aesthetic Consideration. Rivers carrying floating particles common to sewage, do not add to the attractiveness of a water as a source for drinking purposes. No matter how efficient filtration may be, public sentiment is against using water from sources in which direct evidences of sewage pollution can be seen and it is not necessary that such evidence be in the immediate neighborhood of the water intake.

Local Conditions

The extent that the influences noted above will affect any particular water supply will depend on local conditions. For example, the sewage and industrial wastes from the Pittsburg district on the Upper Ohio river do

not interfere with the use of the river water at Cincinnati for domestic purposes, and the presence of these wastes does not place an undue burden on the filtration plant. In this particular case the distance between the two cities on the Ohio River, and the dilution, are sufficient to permit self-purification to take place.

There are, however, many cities and towns located on streams that would furnish suitable water supplies for domestic purposes if it were not for the fact that the time of flow and dilution of sewage from neighboring communities above are not sufficient for self-purification to take place. In such cases, and there are many of them, sewage treatment should be required, the extent, however, depending upon local conditions. Where the dilution is high but the distance between the point of sewage discharge and water intake is comparatively short, fine screens or some form of tank treatment, followed by sterilization may be sufficient. If the dilution and time of flow of sewage discharged into a stream from one city is insufficient to permit self-purification to take place before reaching the water intake of another, complete oxidation in a sewage treatment plant is necessary and in some cases sterilization will be required in addition. Each problem of sewage disposal is, therefore, a special study in itself and before plans are prepared, a thorough examination should be made to learn what the local requirements are and what design of sewage treatment plant will meet them most satisfactorily.

Standards of Treatment

In water treatment plants it has been possible to adopt standards of purification that are practical and they are being maintained throughout the country. In sewage treatment, however, the purpose is not to maintain a standard which will apply to all plants but rather so to modify the sewage that the natural purifying power of the water in the streams will complete the oxidation of the organic matter remaining in the effluent of the disposal plant. In other words, the effluent from water purification plants must conform to well-defined, uniform standards of quality while the effluent from sewage treatment plants may be of varying quality depending on the power of the receiving body of diluting water to bring the purification to the required standard.

The science of sewage treatment has progressed to the point where special processes can be recommended for purifying sewage to any degree required. The type of plant best suited for any given city should be determined, however, by a competent sanitary engineer. Enough money should be available for constructing the plant recommended, and provision should be made for the supervision of the operation. The failure of a large number of sewage disposal plants in operation today to produce satisfactory effluents is due in a very large measure, either to the fact that enough funds were not available to build the treatment plant as large as was recommended by the engineer who designed it, or it has been outgrown, or there is a lack of control over the operation. The mistakes that have been made are not inherent in the principle involved, so that cities wishing to purify their sewage for the protection of water supplies can install and operate properly designed treatment plants with confidence that they will produce the results expected from them.

The question of deciding when one city is discharging more sewage into a stream than its self-purifying powers can take care of before reaching the water intake of another city lower down on the same stream is not always easy to determine. In extreme cases there will be found, on the one hand, situations where the water at the intake of a city will contain direct evidences of sewage pollution such as floating material common to sewage, and on the other hand, places where the only evidence of sewage that can be found in the water will be the increased numbers of bacteria and an excess of organic matter. Only a very superficial examination is necessary in the first case to decide whether sewage treatment is necessary for the protection of a water supply, but at the other extreme a very careful survey of the entire situation must be made, including chemical and bacteriological examinations of the water that extend over considerable periods of time.

Expert Testimony

Formerly when the courts were called upon to decide the relative merits of controversies arising from questions of stream pollution the evidence was, naturally, more or less biased by the purpose for which it was to be used. Even where technical evidence was given there was a tendency to omit data which might not advance the interests of clients. From the very fact that the parties to such a suit were interested primarily in winning their case and due to the fact that judges and jurymen could not be expected to be familiar with the science of sewage treatment, water purification, and the factors entering into stream pollution, it was not always possible to settle cases on their true merits. There never was, however, any doubt as to the fundamental law regarding the riparian proprietory rights, discussed earlier in this paper, but the evidence was lacking in some cases upon which proper interpretation could be made.

State Supervision

A few years ago it became apparent that the courts were not the proper places to decide whether a stream of water had become so badly polluted with sewage that the water was unfit for domestic purposes. It was felt that the greatest use possible should be made of our water-courses in carrying off the liquid wastes from cities and that the authority for deciding when a stream had reached its capacity for carrying sewage should be vested in the state. Accordingly, many states enacted laws for controlling stream pollution and authority for their enforcement has been given to the various state boards of health. For the purpose of carrying out the purpose and intent of these laws, sanitary engineering departments have been developed. These include a chief engineer and assistants, chemists, bacteriologists and laboratory facilities.

It is possible for any state, through such an organization as referred to above, to keep watch over the streams within its boundaries and to require that they be maintained in a sanitary condition. When controversies do arise over questions of stream pollution the states should have the means of collecting the important data by experts and presenting the information in an unbiased manner. However, stream pollution cases between individuals and cities ought never to reach the courts in states

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having a well-organized sanitary engineering department, for the reason that the states should require that corrective measures be applied before conditions reach the point where a law-suit becomes necessary.

The state department of health of every state should have a competent sanitary engineering department with sufficient personnel and equipment to look after the sanitary conditions of all the water-courses within the state. The department will be almost useless, however, if the necessary authority is not given to require that its recommendations be put into effect. The protection of water supplies by enforcement of sewage treatment is a function of the state acting through its department of health, and the extent to which waterways sanitation is enforced will depend upon the laws passed to require sewage treatment, and the personnel and equipment provided to carry out the work.

Interstate Streams

The states have jurisdiction over the rivers and lakes within their boundaries, but there is no authority at present to require cities located on interstate streams to treat their sewage for the protection of water supplies taken from these streams by cities in other states. The industries along our main waterways are sure to increase in size and number and with them the population will grow apace. The time must come, therefore, when the streams can no longer be utilized, as they are today, for carrying off the raw sewage and wastes from large and thickly settled communities without seriously affecting the use of the water for domestic purposes. The National Government alone has the authority to control the pollution of interstate streams, and it would appear to be in the interest of economy as well as the best interests of future generations for the government to guard these streams against excessive pollution that may be difficult and expensive to remove if allowed to progress too far. If laws are passed by the government for the control of sanitation in the interstate streams, they should be closely correlated with the laws of the various states relating to the intrastate streams.

The United States Public Health Service, under authority of an Act of Congress passed in August, 1912, has been making a study of the pollution of the interstate rivers, but this law provided only for an investigation of conditions as they exist today. It is believed, however, that the data obtained will eventually be used as a basis for framing the necessary laws for preserving the interstate rivers of our country as a safe source of water supplies for the large cities located on them.

Acknowledgment

This paper by Mr. Honmon was presented before the 1920 annual convention of the Illinois Section of the American Water Works Association.

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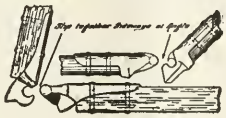

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CONSTRUCTION NEWS AND EQUIPMENT

CONSTRUCTION EQUIPMENT EMPLOYED IN BUILDING REINFORCED CONCRETE PAVEMENT ON JEFFERSON HIGHWAY, RICE COUNTY, MINN.

By P. C. Brown, Assistant Engineer, Rice County, Faribault, Minn.

The paving on the Jefferson Highway, which is being done by Siems, Helmers & Schaffner for Rice County, Minn., extends between the cities of Northfield and Faribault. The work is known as Minnesota Federal Aid Project No. 64, and is 12.9 miles in length. The paving consists of reinforced concrete, mixed in the proportions 1-2-4, with a thickness of 6½ to 7½ ins. This is the Minnesota Highway Department's standard for highway paving. There is to be an earth or gravel shoulder of 4 ft. width, built up flush with the edges of the paving. In laying the grade a maximum of 5% was used. In the equipment listed above, the largest amount of earth moved during any one month was during the month of June, 1920, when the amount of excavation was 18,000 cu. yds.

The final finish is given the subgrade just before the concrete is placed. This work is done largely by hand. A slip scraper is used when holes or depressions are found in the grade. A Lakewood subgrade machine has been ordered, but has not as yet been used.

Handling the Aggregate

The aggregate used in the paving consists of Randolph, Minn., sand and crushed rock from a quarry located about two miles from Faribault and operated by Siems, Helmers & Schaffner. This material is shipped in gondola cars. It is unloaded at two concentration points along the line of paving. The unloading is done by a clam shell bucket, which deposits the aggregate in stock piles. This method of handling the material has proven this method it is possible to keep a large reserve supply

VIEW OF LAKEWOOD CONCRETE MIXING AND FINISHING EQUIPMENT EMPLOYED ON JEFFERSON HIGHWAY CONSTRUCTION BETWEEN NORTHFIELD AND FARIBAULT, MINN.

some places on the project it has been difficult to keep the wet concrete from creeping so it would not be advisable to use any steeper grade than this.

Grading Equipment

The grading equipment being used on the project consists of two elevating graders. One 8 ft. blade grader, 4 fresnos and 14½ yd. dump wagons. Nearly all of the heavy excavation is being done by the elevating graders. Horses are used on all of the grading equipment. A tractor was tried on one of the elevating graders, but its use was discontinued. No roller is being used on the fills, but its use would be advisable where the paving is to be done within two or three months after the grading has been completed. This is especially true on relocations, where there is no traffic between the time of grading and paving. The total amount of excavation on the entire project is about 102,000 cu. yds., and, with on hand. There has been some difficulty in getting to be very satisfactory, as there is little waste, and with enough freight cars to handle the transportation, but up to the present time it has not been necessary to shut down on account of lack of supplies. At first bulk cement was used, but this proved to be too difficult to handle and caused quite a lot of waste.

Industrial Railway.

The material is transported from these concentration points to the mixer by means of an industrial railway. Two gasoline and two steam locomotives are used on the project. The trains consist of 5 to 7 cars, each car carrying two boxes. The boxes have a capacity of ¾ cu. yd., or one batch. The gasoline locomotives are used to take the material out on the project, while the steam locomotives are used at the loading point to handle the cars as they are being filled.

These industrial trains are loaded at the concentration

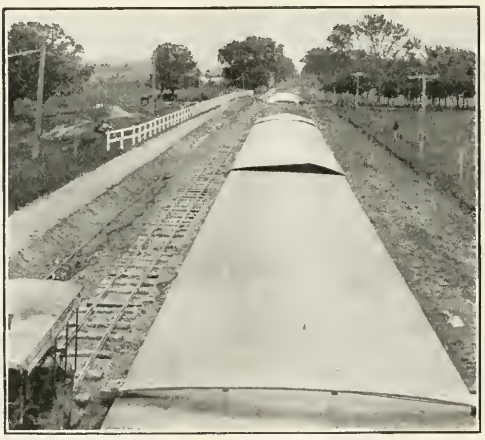
Printed as insert to MUNICIPAL AND COUNTY ENGINEERING, Chicago, Ill., September, 1920.

points with the proper proportions of aggregate and cement in each batch box. The same clam shell bucket, which unloads the gondola cars, takes the material from the stock piles and places it in large hoppers. The boxes are run under these hoppers and filled by gravity. The rock is placed in the bottom of the car, the cement next, and the sand on top. These trains are run up to the mixer and the boxes are lifted to the top of the feeding hopper by means of a steam hoist. The boxes are equipped with dump bottoms and are dumped directly into the mixer as soon as the preceding batches have been run out.

Mixing, Placing and Finishing Concrete.

The mixer used on the project is a Lakewood ¾-yd. machine. It is placed on the subgrade just ahead of the concreting. The mixer is moved by means of a 35 h. p. Minneapolis steam tractor. This tractor furnishes steam to operate the mixer and the hoist lifting the batch boxes.

The concrete is mixed for one minute and then run on to the subgrade by means of a chute. The finishing is done by means of a Lakewood finishing machine. This machine gives fairly good satisfaction, but with one exception, which is worth while noting. When the first three miles were thrown open to traffic it was found that the surface of the pavement was rough in places, espe-



METHOD OF CURING CONCRETE ON JEFFERSON HIGHWAY, RICE COUNTY, MINN.

After Finishing, Pavement Is Covered with Canvas Stretched on Bows Strung with Wire. After Initial Set Canvas Is Removed and Earth Covering Is Sprinkled On. This Earth Is Kept Moist for Two Weeks and Then Removed. In Another Week Pavement Is Opened for Traffic.

cially on the slopes. It seemed that when the finishing machine was run over the surface the tamping caused the wet concrete to bulge up somewhat in the rear of the machine. At first it was thought that this was due to the fact that the forms were not placed on the proper supports, but on closer examination it was seen that it could not have been caused in this way. As soon as this roughness was noticed methods were used to prevent it from occurring in any more of the pavement which was to be placed. The forms were placed on better foundations and two finishing machines were used. Up to the present date none that has been finished this way has been thrown open to traffic.

A force of 95 men is used to handle the unloading apparatus, the industrial railway and the mixing plant. With this force, during the month of May, 1920, 15,199 sq. yds. were placed.

Curing

As soon as the finishing machine has been run over the surface of the concrete for the last time it is covered with a canvas cover made of canvas stretched on bows of 6-in. boards, strung with wire. When the concrete has taken its initial set the canvas is removed and a covering of earth is sprinkled over the surface. This earth is kept moist for a period of two weeks, after which it is removed and in another week the pavement is ready for traffic.

NEW METHOD OF HANDLING CONCRETE MATERIAL ON MINNEAPOLIS PAVING JOB

By Ellis R. Dutton, Assistant City Engineer, City Hall, Minneapolis, Minn.

In these times of the high cost of labor, it is very essential to take advantage of labor saving machinery and to introduce it wherever that can be done. In paving work the largest percentage of labor is in the construction of concrete.

Not only has the price of labor greatly increased but it is also true that the efficiency has decreased, thereby adding more to the high cost. There have been various devices, designed to reduce the labor necessary in concrete work, which have been more or less successful—but most of them have not been sufficiently elastic to take care of contingencies that arise in all work. If everything was placed just so and all went well they were all right. In our old method, we planked the sub-grade and hauled the materials on the plank and used wheelbarrows to get it into the mixer. This was all right when the prices of lumber and labor were cheap and before the use of trucks for delivery, but at the present price of lumber and the destruction by truck, it is out of the question.

With the introduction and perfection of the bucket loaders, the shoveling of the aggregate was done away with but we still had the problem of getting the material from the loader to the mixer. It was only recently that a truck tractor was introduced, having a dumping body, which would hold a cubic yard of material and which when used in connection with the bucket loader, would seem to solve the problem. This combination is flexible, enabling one to haul the material 25 ft., or a block or two blocks or even more, the only requirement being to use sufficient trucks to keep the mixer going. In the ordinary way, using shovels and wheelbarrows and using two bag batches of 1-3-6 mixture, it would require about 16 men for the coarse aggregate. In using the loader tractor combination it would require 3 men for the short haul and 1 additional for each tractor, making for a block haul 6 men, giving a saving of 10 to 13 men, less the cost of the upkeep and fuel for the loader tractors. The pictures here show where the equipment was used on a street with a car line. In this case the coarse aggregate was dumped on the sub-grade from the car tracks and therefore it only required one truck tractor to keep the mixer going. The sand was dumped on the opposite

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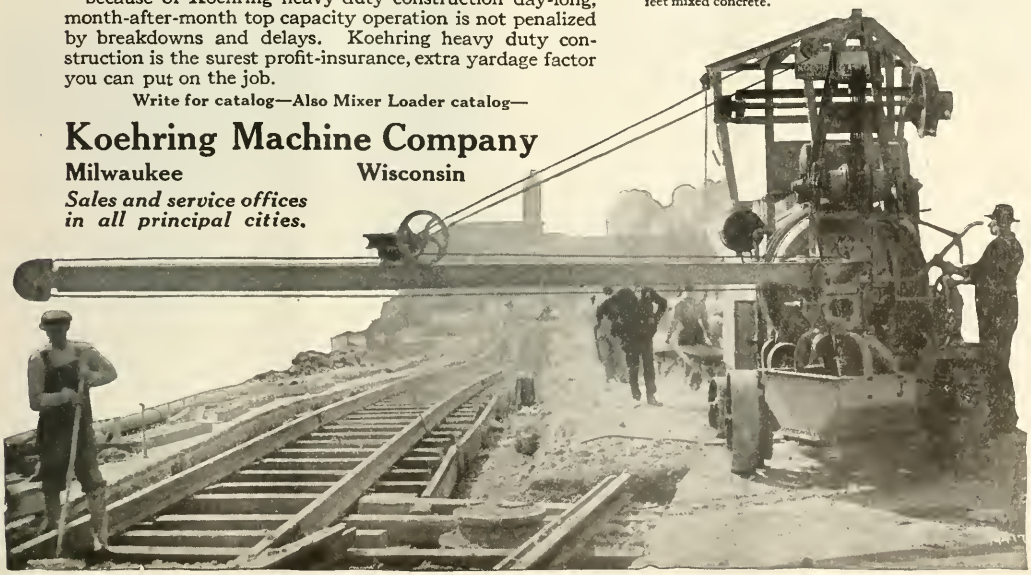
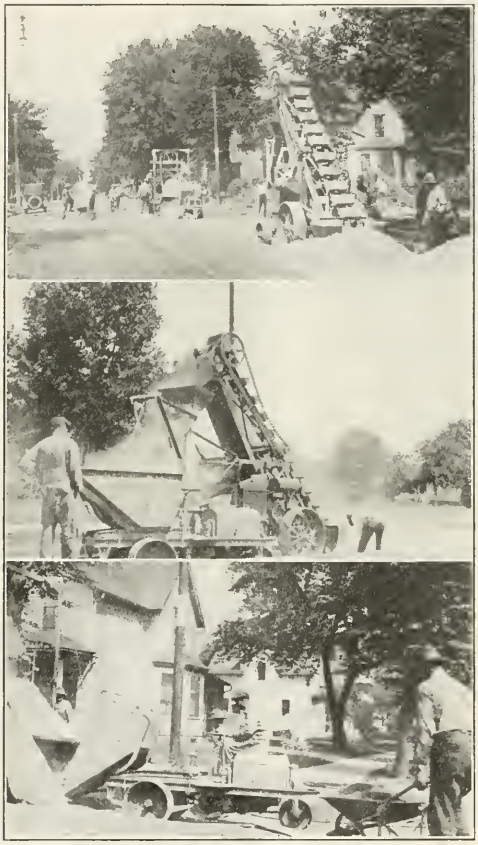


side of the street near the mixer and only required three men, with wheelbarrows, to place it in the mixer and making it about as cheap to use wheelbarrows.

There have been other methods suggested for use with the truck tractor, one being the use of portable



VIEWS OF LABOR SAVING EQUIPMENT USED ON PAVING WORK IN MINNEAPOLIS, MINN.

Top: General view of paving operations on East 25th St., July, 1920. Center: Loading Clark Tructractor with Barber-Greene Loader. Bottom: Dumping Tructractor into mixer loading skip.

bins from which the tractors were to be loaded. These bins were loaded by a clam shell. Still another system was using a stationary mixer and hauling the mixed concrete to place on the street. In any of these methods, there is considerable saving of labor, thereby reducing the high cost of construction.

LARGEST MIXERS BACK IN SERVICE AFTER 60-FT. FALL

Recently, a fire at Wilson Dam, part of the Muscle Shoals project under Government construction, destroyed the tressle work at the cement shed. Two very large Smith tilting mixers, the largest in the world, capacity 4 cu. yds., fell approximately 60 ft. from their mounting on this tressle work. At first it was thought it would be necessary to replace the mixers entirely, but after careful examination it was found that proper repairs would return them to good working order. In spite of the terrific heat to which these machines were subjected in addition to a fall of 60 ft., practically no castings were broken. All the gears except the bevel gears survived the shock perfectly. Just three teeth in the main gear ring were smashed.

These mixers have both been in Government service for several years. Besides these two which were made for the Government, four others of this size were made for the Hardaway Construction Company several years ago, by The T. L. Smith Company, General Sales Offices,

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THERE is a growing appreciation among engineers and contractors of the fact that the dragline cableway excavator method, so universally employed by commercial gravel-handling plants, can be utilized for other work involving excavating and moving materials over distances of from 100 to 800 feet or more

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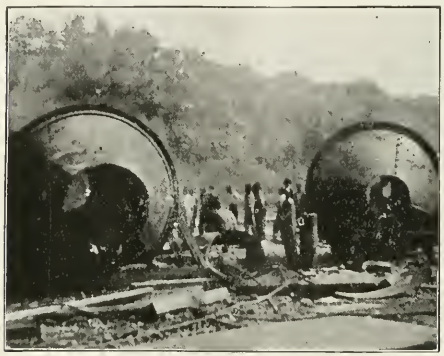
Chicago, Ill. They are the only mixers of this size ever built.

Each mixer weighs about 48,000 lbs. and has a capacity of 112 cu. ft. of mixed material, or 168 cu. ft. of loose, unmixed material. They are mounted on steel skids and each is equipped with gated batch hopper and frame, power tilting device and friction clutch pulley. The remarkable feature in their operation is that the entire mixed batch is discharged at one time by automatic



VIEW OF SMITH 4 YD. MIXERS AFTER 60 FT. FALL.

tilting of the entire drum, which revolves as it discharges. It is the same principle as dumping a bucket up-side down to empty it. This tilting principle as applied to mixers of this size gains enough time in discharging to enable the same sized crew to pour about 150 to 200 cu. yds. more per day than any type of non-tilting mixer could possibly pour.

LAUSON SPECIAL ROAD TRACTOR

Tractors are now playing a conspicuous part in road construction work. The ability of tractors to stand up under hard work without tiring or easing up makes them preferable to horses and mules.

Many manufacturers are building tractors especially designed for road work. The accompanying illustration

LAUSON KEROSENE TRACTOR ON ROAD CONSTRUCTION WORK, NEAR KANSAS CITY, MO.

shows the Lauson Full Jewel Kerosene Tractor on construction work near Kansas City, Mo.

This machine has heavy cast rear drive wheels, which give the necessary traction and prevent slippage on loose dirt roads, such as shown in the illustration. All gears are enclosed and run in a bath of oil. They are well protected from dust and dirt.

PERSONAL ITEMS

Mr. W. G. Thompson, until recently State Highway Engineer of New Jersey, is now associated with the Lakewood Engineering Co., with headquarters at 141 Centre Street, New York City. Mr. Thompson's first engineering experience was with Charles A. Nichols, a civil engineer of New Haven, Conn., on general surveys and engineering work covering water works, and street railway location and construction. In 1904 Mr. Thompson was with the United States Engineering Department as inspector of dredging and break-water work on Long Island Sound. From February, 1905, until March, 1910, he was a member of the Engineering Department of the Panama Canal, engaged in general survey and construction work, including topographical and railroad surveys, railroad and shop building construction. From May, 1910, until June, 1911, Mr. Thompson was employed as a draftsman in the Chief Engineer's office of the Oregon & Washington Railroad in Seattle, engaged principally on passenger terminal and freight classification yard layout. From June, 1911, to June, 1916, he was employed as Supervisor and Superintendent of Construction on the

W. G. THOMPSON

locks and terminal facilities of the Panama Canal. His work included the construction of reinforced concrete wharves, foundations, and of shop buildings, as well as the general construction of terminal facilities. During this time Mr. Thompson was in full charge of the construction of the Cristobal Coaling Plant, at the Atlantic entrance to the Panama Canal. From November, 1916, until April, 1917, Mr. Thompson was employed by the Raymond Concrete Pile Company of New York as superintendent on the construction of the Sun shipyard at Chester, Pa., and later as superintendent of construction for the Raymond Company at the Bethlehem Steel Plant

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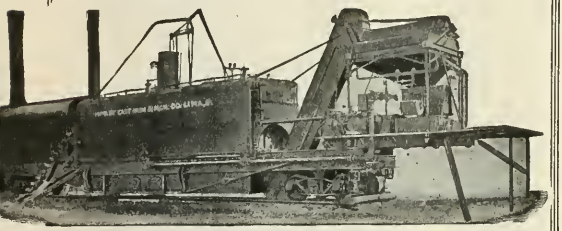

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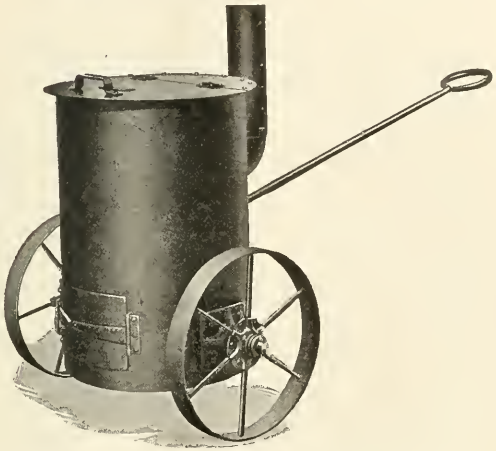

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at Steelton, Pa. In April, 1917, he was appointed Assistant State Highway Engineer of New Jersey upon recommendation of General George W. Goethals, then Consulting Engineer to the State. In April, 1918, Mr. Thompson was appointed State Highway Engineer, having full charge of the State Highway Department and its work.

Mr. Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport at the University of Michigan, has recently been appointed Consulting Engineer to the Michigan State Highway Department.

Mr. Charles A. Haskins, Chief Engineer, and Director of the Water and Sewerage Laboratories, of the Kansas State Board of Health, has resigned to associate himself with Black & Veatch, Consulting Engineers, Kansas City, Missouri. Mr. Haskins has been connected with the Kansas State Board of Health for nine years, with the exception of a leave of absence in 1915, spent with the United States Public Health Service in the Investigation of the Pollution of Coastal Waters. Mr. Haskins served during the war as a Captain in the Sanitary Corps, detailed to the office of the Surgeon General on special investigations of water and sewerage problems.

Mr. James W. Routh, C. E., Director and Chief Engineer of the Rochester Bureau of Municipal Research, Inc., Rochester, N. Y., announces that he is available for service as consulting municipal engineer, and is prepared to conduct investigations, prepare plans, specifications and reports, and supervise operations in connection with all municipal engineering activities. Special service can be rendered municipalities interested in improving the organization and administrative procedure of their departments of government. Offices, 501 Arlington Bldg., Rochester, N. Y.

Messrs. Langdon Pearse and Samuel A. Greeley announce that Mr. Paul Hansen, formerly chief of the division of sanitation and engineering of the Illinois State Department of Health, has become a member of their organization. The firm will continue its professional practice under the name of Pearse, Greeley & Hansen, with offices at 39 West Adams Street, Chicago, specializing in water supply, water purification, sewerage, sewage treatment, industrial sanitation, garbage and refuse disposal, valuation, works operation, design, and supervision of construction.

LeRoy K. Sherman, who has had charge of the construction and salvaging of government housing for industrial war workers, has resigned as President of the United States Housing Corporation, Washington, D. C., and has returned to Chicago. Mr. Sherman has become associated with the Edmund T. Perkins Engineering Company as Vice-President. Mr. Sherman is a Civil Engineer and graduate of Massachusetts Institute of Technology. He is President of the American Association of Engineers, and was formerly the engineer member of the Illinois State Rivers and Lakes Commission. The Edmund T. Perkins Engineering Company will conduct a general practice as consulting engineers in municipal and sanitary work in addition to their specialty of land drainage and reclamation.

Dow & Smith, Consulting Paving Engineers, announce that they have established a branch office at Columbia, S. C., at 1327 Main St., which is in charge of T. Keith Legaré, District Engineer. Mr. Legaré was formerly connected with the engineering department of the city of Columbia for eleven years, and has had extensive experience with various types of street paving. After resigning as city engineer of Columbia, he entered private practice as consulting engineer, specializing on municipal engineering, but has recently discontinued this part of his business.

MOTOR TRUCK NOTES

Performance of a Duplex Limited Truck

From Hartford, Connecticut, to Lansing, Michigan, and back between Tuesday noon and early Saturday afternoon is the record of a Duplex Limited Truck according to Russell P. Taber, Inc., Duplex dealers in the Hartford territory. Outside of changing one tire, not a nut or bolt on the truck was touched and the average of gasoline was nearly 10 miles per gallon for the entire trip both ways.

The truck arrived from Hartford with more than 3-tons of rims and bearings. The return trip was made with a load of 5,200 lbs. The Duplex Limited arrived in Hartford fifteen minutes ahead of several other trucks which left Lansing one day earlier.

Truck Stamina

L. Ferger, a New York contractor, who has ten 5½-ton Macks, reports rather unusual emergency service from them. For a period of three months, he says, five of these trucks averaged 220 miles every 24 hours, working continuously to the extent that the motors were never cold. Again during the coal shortage and severe winter of 1918 five more hauled coal day and night for several months. Nine of the ten have never missed a day's service on account of repairs, and the other—a five year old model—just recently required cylinder reboring.

Burley Preston, of Arlington, Wash., has a 2-ton Mack that averaged 149½ miles daily for 830 consecutive days including Sundays and holidays without missing a trip. During these 2 years and 3 months, the truck had a steady 24 hour-a-day grind hauling logs during the day and milk during the night. Constant overloads always exceeding 100 per cent. were a further requisite to Mr. Preston's emergency demands and in spite of all this strenuous service, he can prove that his cost of maintenance for the period was less than one cent a mile.

Schafer and Schafer, also of New York, ran their 5½-ton Mack 24 hours a day 7 days a week always heavily overloaded for 31 consecutive weeks between New York and Philadelphia, without missing a day. It stopped then for a minor repair to one of the wheels, after which it continued the same grind for several months more. Then the Sunday trip was omitted and it has since made the same trip six days a week.

Two Mack AB's in the service of A. E. Buck, East Arlington, Vt., worked 24 hours a day for 5 months on a rush government lumber contract their owner secured. He employed three shifts of drivers, working the trucks day and night and for the five months the motors were never cold. They are now doing the work of 20 teams

and are hauling lumber at the rate of 3,000,000 feet a year.

Gramm-Bernstein Expands

At a meeting of the directors of the Gramm-Bernstein Motor Truck Company, held at the offices of the Company in Lima, Ohio, on July 31st, a stock dividend of 50 per cent. was declared out of surplus earnings to the common stock holders of record and it was also voted to increase the capitalization from $1,500,000.00 to $5,000,000.00, the entire amount to be issued as common stock.

The company, which has been unusually successful from the start and has averaged earnings of 25 per cent. per annum on its common shares for the past five years, has heretofore been closely controlled by the two principals, Messrs. Gramm and Bernstein, but the quality of its product, the prestige gained from the prominent part which they played in the making of the first Liberty Truck, which was later followed by orders for several thousand additional trucks, has since created such an enlarged demand for their product as to make the increased capitalization necessary for the proper conduct of their future business.

The company has built up a high class and closely knit organization who will now be given an opportunity to share equally with the principals through being given the right to purchase common stock. It is the expressed intention of the principals also to offer a limited amount of the stock to the public.

CONTRACTS AWARDED

ROADS AND STREETS

Ala., Anniston—J. F. Morgan Paving Co., awarded contract for paving Noble and 15 Sts., at $133,851.

Ala., Bessemer—J. S. Morgan Paving Co. awarded contract to pave 1st, 2nd and 4th Aves. and 19th St.; Sullivan, Long & Haggerty, contr. for grading, curbing and sewers. Total cost of work, $269,566.

Ariz., Florence—R. Toohey, Florence, awarded contract in modified form for constructing Secs. 2, 3 and 4, Casa Grande-Tucson Highway. Pinal Co., at $132,332.

Cal., Marysville—Warren Constr. Co. awarded contract for constr. of District 10 Highway, at $191,000.

Cal., Visalia—E. E. Herdman, Visalia, awarded contract for paving Worth-Springville Div. Tulare Co. Highway, 9.09 miles, with 1:2:4 concrete, 4 in. thick, at $11,917. County will furnish materials, estimated to cost $67,067.

Ct., Hartford—Linberg & Street, 294 Washington St., Boston, awarded contract for bldg. 11,400 ft. 3-in. native st. macadam over 7-in. broken stone, Columbia-Vernon Highway, at about $100,000; also contr. for 3,650 ft. highway through Columbia Twp., at $25,000; road work in Brookiyn and Hampton Twps., to J. Arborio, 80 Park St., New Haven, at $200,000; 5,560 ft. Cooks Hill Rd., New Fairfield, to J. De Michael & Bros., 58 High St., Torrington.

D. C., Washington—Cranford Paving Co., Washington, D. C., awarded contract to lay 39,000 sq. yds. sheet asph. pavements. $392,000 available for this and contract awarded to Corson & Gruman, Ocean City, N. J., for 27,000 sq. yds.

Fla., Tavares—J. Y. Yeats Co., Tampa, awarded contract for paving 2 miles streets, 30 and 40 ft. wide, asph. conc., at about $92,000.

Ga., Griffin—Reese & Waldrup Constr. Co., Augusta, Ga., awarded contract to construct 4.9 miles paved road between Griffin and Jackson Rd., at $126,000.

Ga., Moultrie—Atlantic Bitulithic Constr. Co., Washington, D. C., awarded contract to pave streets here at $250,000.

Ga., Winder—Passmore-Davis Constr. Co. Georgia Casualty Bldg., Macon, Ga., awarded contract to construct 17,000 yds. pavement; 7,000 ft. curb; ½-mile sewers, etc. $100,000 available.

Idaho, Blackfoot—J. C. Maguire Co. awarded contr. for 40,000 sq. yds. Warrenite-Bitulithic pavement on 3-in. dense bitum. conc. base.

Idaho, Idaho Falls—J. C. Maguire Co. awarded contr. for 47,684 sq. yds. Warrenite-Bitulithic pavement on 4-in. concrete base.

Idaho, Sand Point—Chas. McKenzie, Colfax, awarded contract for Rd. Proj. 19 (12 miles 22-ft. rdway), from 4 miles north of Sand Point to Bonner Co. line, at $185,000; General Constr. Co., Spokane, awarded contract for 17 miles in Boundary Co., at $198,000. Clyde Chaffins will be resident engineer and inspector on both jobs.

Ill., Springfield—Dept. Pub. Wks. & Bldgs. let contracts for bldg. following sections; Vandalia-Cairo Hwy.: Sects. 24A, 25A and 26A, Fayette and Marion counties, to Frazier-Davis Constr. Co., Arcade Bldg., St. Louis, Mo., at $56,000; Sects. 26A and 28A, Marion Co., Sec. 30A, Marion & Washington Cos. Sects. 32A and 33A, Washington Co. to Cameron-Joyce & Co., Keokuk, at $94,841; Sect. 29A, Marion Co., to Embankment Co., Joliet, at $21,623.

Ill., Springfield—Awen & Warfield, Lincoln, awarded contract for grading Springfield-Danville Hwy., at $40,843, and Salisbury Rd., at $25,346.

Ia., Marshalltown—A. Carlson, Marshalltown, awarded contract for Dist. No. 2, at $35,716; Dist. No. 4, $28,681 and Dist. No. 6, at $107,200.

Ind., Indianapolis — Posey & Parsons, Evansville, awarded contr. for grading and culverts on State Hwy. Proj. 16, Sec. F. Dubois Co., at $131,755; Richards & Ellis, Rockport, awarded contr. on grading & culvert work, State Hwy. Proj. 16, Sec. E, Dubois Co., at $83,923.

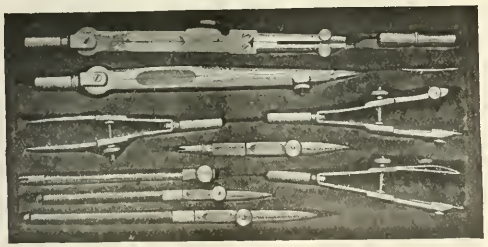
Ia., Osceola—L. L. Beye, Eldorado, Kas., awarded contract for 2 mi. asph. paving, at $152,544.

Ia., Primghar—O'Brien County let contracts for bldg. 5 miles Hwy. involving 52,800 sq. yds. rein. conc. pavement, to J. H. Johnson, Royal, at $208,032 8.5 miles, $9,760 sq. yds. rein. conc. to Capital Constr. Co., Des Moines, at $385,978; 9 mi., 95,040 sq. yds. rein. conc. to O'Rourke Eng. Co., Des Moines, at $403,918; 60,000 lin. ft. tiling, to L. Johnson, Hartley.

Me., Augusta—Greenwood Constr. Co., Showhegan, awarded contract for bldg. 6.12 miles gravel road, Littleton, at $117,987; rebldg. Gagnon brdg. Frenchville, to Bd. Selectment, Frenchville, at $10,800.

Mass., Boston—C. Bianchi & Co. Inc., Framingham, awarded contract by State Hwy. Comm. for bldg. 3,300 ft. highway, Leicester, at $61,023; Warren Bros. Co. 142 Berkeley St. awarded contract for paving Clarendon St., bitulithic, at $12,614; 1,162 ft. Blackstone St. to J. Landis, at $18,633.

Mich., Harrisville—Hill & Lonte, Whittemore, awarded contract for grading and



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surfacing & draining 5.938 mi. F. A. Rd. 33, Sec. A, involving 62,434 sq. yds. gravel, 930 lin. ft. pipe culvts., 419 cu. yds. concrete in culvts. etc., 175 lin. ft. guard, at $103,145.

Mich., Lansing—Road Comn., Muskegon, Co. Muskegon, awarded contr. for surfacing and grading 3.956 mi. F. Aid Rd. 1, Sec. A, 16 ft. wide, at $120,709; T. W. Edison, Rogers, awarded contract for grading, draining and surfacing 5.938 mi. F. A. Rd. 33, Sec. B, 16 ft. wide, Alaecona Co., involving 24,926 cu. yds. earth excav., gravel surfacing, steel reinforcement, culverts, etc., at $77,895.

Minn., Caledonia—Thornton Bros. Co., 304 Central Bank Bldg., St. Paul, awarded contract for road work, at $237,762.

Minn., Duluth—Foley Bros. & Nelson, St. Paul, awarded general contr. for constr. of 3.1 miles rd. constituting Carlton Co. approach to Fond du Lac brdg. over St. Louis river, at $75,720.

Minn., Little Falls—General Contg Co., 1228 Plymouth Bldg., Minneapolis, awarded contr. for pav. abt. 14 blks. 1st St. S. E., 2nd to 6th Aves., involving 38,000 sq. yds. bitulithic on macadam foundation, at about $150,000.

Minn., Mora—J. J. & M. S. Mergens, 403 Kasota Bldg., Minneapolis, Minn., awarded contracts for F. A. P. No. 91, State Rd. No. 2, at $139,000.

Minn., Rush City—W. S. Harris Co., Minneapolis, and C. Johnson, Sandstone, awarded contr. for 7 mi. conc. paving and 33 mi. grading on Fed. Aid Proj. 95, State Rds. 5, 2 and 1, at total of $488,000.

Mo., Carthage—Carterville Constr. Co., awarded contract for street paving to amt. of $220,000.

Mo., St. Louis—Board Pub. Wks. awarded following contracts: O. S. Brighton, reconstruct Marcus, Lawton, Lafayette and Union Aves., at $222,865; Granite Bitum. Paving Co., contract to improve Skinker Rd. and Maple Ave., at $64,093.

Mont., Gt. Falls—S. Birch & Sons, awarded contr. for 13,000 sq. yds. Warrenite-Bitulithic pavement on 4-in. concrete base.

N. J., Hoboken—W. T. S. Crichfield, Washington St., awarded contract for improvement of 1st St., at $93,805; Monroe St., 8th to 9th Sts. and various other streets, Blegium blk., to Letteri & Belezza, Jersey City, at $791,245.

N. J., New Brunswick—H. N. Scott, Cranbury, awarded contract subject to approval of State Hwy. Comn., of Helmetta Rd. Impvt., at $74,379.

O., Akron—Columbia Asphalt Co., 708 2nd Natl. Bank Bldg., awarded contract for paving Silver Lake Blvd., at about $160,000.

O., Alliance—Highway Construction Co., awarded contract for rebuildg. abt. 4 mi. of Alliance-Limaville Rd., at $92,000.

O., St. Clairsville—McClain Constr. Co., Bellaire, awarded contract for paving 2 miles Flushing-Unionetown Rd., concrete, at $78,000; 2.5 miles Martins Ferry-Colerain Rd., brick, to Clifford & Shannafelt, Bellaire, at $110,000.

Okla., Lawton—Allen & Harrison, Okla. City, awarded contract to construct 6 mi. gravel road in Comanche Co., at $73,401.

Ore., Astoria—Northwest Constr. Co., Portland, awarded contracts involving expenditr. totaling $189,226 for street impvts. Bids include bulkheads, sand or earth fill, necessary anchor rods, walks, etc.

Ore., The Dalles—United Contractg. Co., awarded contr. for 12,547 sq. yds. Warrenite-Bitulithic pavement on 4-in. compressed stone base.

Pa., Harrisburg—C. E. Weed, Inc., Albany, N. Y., awarded contract for 2,635 ft. one-course rein. conc. 18 to 29 ft. wide, Delaware Co., Millbourne Boro. and Upper Darby Twp., Route 133, at $36,084; also 7,441 ft. one-course rein. conc., 18 to 33 ft. wide, Northampton Co., Bangor Boro., at $110,673; M. Bennett & Son, Indiana, Pa., contr. for 13,625 ft. one-course rein. conc., 18 ft. wide, Westmoreland Co., Derry Twp., State-aid application No. 965, at $190,030.

R. I., Providence—J. Bristow, Narragansett Pier, awarded contr. by State Bd. Pub. Rds. State House, for bldg. 2 miles of rd. from 1,000 ft. so. of Nanaquaket Brdg. so. on Sakonnet Point Rd. town of Tiverton, at $87,652.

S. C., Columbia—White & Simpson, Chatham, Va., awarded contract for bldg. 20 miles Columbia-Saluda Rd. gravel, at abt. $123,000.

Tenn., Bristol—Municipal Paving & Construction Co., awarded contract for street impvt. work, estimated at $115,000. Work includes 7 districts.

Tenn., Selmer—Evans & Meade, Florence, Ala., awarded contract to construct roads; $600,000 available.

Tex., Henderson—Tipple Constr. Co., Mineral Wells, Tex., awarded contract to construct 45 miles of roads, at $350,000.

Tex., San Antonio—Southwestern Bitulithic Co. and Uvalde Co., awarded contracts to pave 21 streets, Uvalde rock asph. and bitulithic; 24-in. pavements on macadam base, at $560,000.

Tex., Van Horn—W. E. Hamilton, Mineral Wells, awarded contracts for improving 23.356 mi. Hwy. 12, 9 ft. wide; also 43.167 mi. Hwy. 1, 9 ft. wide, at $31,984 and $114,990 respectively.

Tex., Wichita Falls—Potts & Prentice, awarded contract to improve 8.81 miles highway; Fed. Aid Proj. No. 3; 4.68 mi. Hwy. No. 3, F. A. Proj. 61; concrete, at $648,845.

Vt., Montpelier—G. L. Gregoire & Co., Barre, awarded contract for bldg. 1.26 mi. State Hwy. Proj. 16, E. Montpelier, involving 2,910 cu. yds. gravel, 139.5 cu. yds. conc., 5,827 cu. yds. earth and 100 cu. yds. rock excav., 2,533 cu. yds. stone base, 1,381 cu. yds. borrow, etc., at $35,852; 4.03 miles Proj. 15, So. Burlington and Shelburne, to W. T. Thayer & Co., Chateaugay, N. Y., at $119,967; 5.6 mi. Proj. 14, Dummerston, 14,106 sq. yds. gravel, 546 cu. yds. conc. 1,497 cu. yds. bitum. macadam, etc., etc., to Fallkill Constr. Co., 1 Washington St., Poughkeepsie, N. Y., at $124,083.

Wash., Vancouver—Warren Constr. Co., awarded contr. for 33,700 sq. yds. Warrenite-Bitulithic pavement on 4 in. compressed stone base.

W. Va., Charleston—Kanawha County Commrs., awarded following contracts: Abbott Bros., Sec. 4; Towles & Company, Princeton, W. Va., Sects. 5 and 6; Randish Constr. Co., Sec. 8, on Paint Crk. Total amt. of contracts, $271,000.

W. Va., Moundsville—N. M. Leigh, Mannington, W. Va., awarded contract to grade and drain 3 miles Cameron & Poplar Spgs. rd., at $138,000.

Wis., Superior—M. Peabody, Young & Co., St. Paul, Minn., awarded contract for Sec. 2 & 3, State Hwy. 35, at $561,122.

SEWERAGE AND SEWAGE TREATMENT

Ala., Bessemer—Sullivan, Long & Hagerty, awarded contract to construct storm sewers on 20th and 22nd streets, also pave streets, at $269,566.

Ariz., Phoenix—Ford, Morgan & Co., awarded contract for 20 mi. of trenching and backfilling on Verde river pipe line, at about $80,000. Comn. will do the trenching on another 6 miles.

Cal., Los Angeles—M. Chutuk, 1506 Pleasant Ave., awarded contract for constructing cement pipe sewer in 85th St. and Moneta Ave., sewer district, at $33,629; R. D. Zaich, 220 W. 56th St. contract for cement pipe sewer in 2nd Ave., at $1,999.

Cal., Los Angeles—Following contracts awarded by Bd. Pub. Wks.: Leo Miltich, 616 W. 54th St., vit. pipe sewer in Mariposaa Ave., at $2,100; also cement pipe sewer in 81st St. and Hoover St. Dist., at $17,773; B. Deragno, 1614 S. Hill St., cement pipe sewer in New Hampshire Ave., at $1,797; A. J. Wuletich, 1948 E. 2nd St. cement pipe sewer in San Pedro St. & Florence Ave. Dist., at $32,970; B. D. Zaich, 220 W. 56th St., cement pipe sewer in 68th St. Dist., at $25,400; S. Zarufica, 3006 6th Ave., vit. pipe sewer in Helios Dr. Dist., at $5,187.

Colo., Ft. Collins—M. Johnson & Co., Boulder, awarded contract for bldg. storm sewers in Whitcomb and Whedbess Sts. and Oak and Laurel Sts., at about $102,000.

Conn., New Haven—Dwyer & Mannix, 333 Sheldon Ave, awarded contr. for bldg. 6,000 ft. sewer in Westville Sect., at $31,365.

Conn., W. Haven (New Haven, P. O.—Dwyer & Mannix, 335 Shelton Ave., New Haven, awarded contract for bldg. storm sewers in various streets, at about $25,000.

Ida., Nampa—Helm & Davis, Boise, awarded contract for constr. of 17 miles of lateral sewerage, at $25,000.

Ia., Bancroft—C. N. Gfellefald, Forest City, awarded contract for constr. of sewer system; $86,000; disp. plant, to H. R. Ash.

Mass., Boston—Antony Cefalo, awarded contract for sewerage works in private land and Babcock St., between Salt Creek outlet and Commonwealth Ave., Brighton, at $10,217.

Mass., Boston—Jas. J. Conway, awarded contract for bldg. sewerage works in Chestnut Hill Ave., Brighton, at $12,484; Jos. Todesca, awarded contract for sewerage work in private land and Paine St., near Brook St., West Roxbury, at $6,134.

Mass., Lynn—A. Cefalo, 316 Belgrade Ave., Roslindale, awarded contract for bldg. vitr. pipe sewer in Market St., at $73,651.

Mich., Detroit—City let contr. to N. Mancini, 580 Concord Ave., for bldg., Springle Ave., san. sewer, at $57,750; W. Blanck & Co., 827 Ford Bldg.; Jno. R. Arm, $57,145; to J. Porath, 23 McGraw Bldg., Swift Ave., Arm, Puritan Ave., Arm and Oakland Ave., Arm., $66,550, $65,912 and $54,840 respectively.

Mich., Pontiac—Dan Stevens, local, awarded contract for constr. of san. sewer in Ardmore St., from main sewer to E. Pike St., at $1,447; Geo. Pontarelli, Chicago, awarded contract for 1st section of main sewer to be built with part of the $550,000 voted for san. sewer purposes. This is an open ditch job and extends from city's present outlet to Union St. and parallels the Clinton river. Contractor offered to take work at $21 per ft. for 84-in. sewer; $23 for 48-in. pipe, $4,500 for putting sewer under river at one point where it is necessary; $200 for special manhole; $100 each for 9 stand. manholes; $2 cu. yd. for moving earth where it is desirous of straightening river and altering present course. Bids will be called for and opened Oct. 4, at City Hall for Sections 2 and 3 of this sewer, (tunnel work). City Clk. Luebke.

Minn., LeRoy—O'Neil & Preston, Minneapolis, awarded contract for sanitary sewers, at $52,000; 20,000 ft. 8 to 12-in. sewer.

Minn., Mankato—Following contracts let for Ditch No. 57: Tile work to Frank F. Esser, local, at $136,000; open work, to Mulgrew & Sons, Dubuque, at $15,000, also spreading spoil bks., $300 per lin. mile.

Minn., Pine Island—J. G. Rae, Tracy, Minn., awarded contract to complete san. sewer system, at $40,577; 7 to 15-in. sewer, 5 to 15-ft. deep.

S. D., Rapid City—Geo. M. McDonough, awarded contract for storm sewers.

Mo., Kansas City—M. Walsh & Son, awarded contract for constr. of sewer in alley between Baltimore Ave. and Main St., from 18th to 21st Sts., at $35,930.

Mo., Kansas City—Kinlen Constr. Co., awarded contr. for bldg. comb. storm and san. sewer in district south of 65th St., at $31,330.

Mo., Kansas City—T. M. Torson Constr. Co., 362 S. 10th St., Kansas City, Mo., awarded contract for constr. of sewer at $118,575; W. D. Boyle Constr. Co., 709 Railway Exch. Bldg., Kansas City, Mo., for constr. of sewer, at $14,985.

Neb., Alma—Art. A. Dobson Co., Lincoln, awarded contract for constr. of complete sewerage system for city, at $69,009.

N. J., Haddonfield—W. P. Corson, 1141 Sycamore St., Camden, awarded contr. for bldg. 2 sewage disp. plants and laying one mile terra cotta sewer pipe, at about $130,000.

N. J., Irvington (Newark P. O.)—J. Doren, 646 Nye Ave., awarded contr. for bldg. sewer and paving in Alpine St., Grove to 21st Sts. at $16,600.

N. D., Hankinson—Jno. O'Connor Co., Fargo, awarded contract for complete sewer system, including septic tank and sludge bed, at $82,000.

O., Cleveland—Gallagher-Burge Constr. co., awarded contract for construction of sewer in Scoville Ave., at $90,000; A. J. Galvin, awarded contract for constr. of sewer in Nelson Ave., Sec. 99th to 112th St., at $28,200.

O., Cleveland—W. McDowel & Son, 10319 Miles Ave., awarded contr. for bldg. sewers in Miles Ave., from old to new city limits, at $30,879; Nelson Ave., E. 99th to E. 112th Sts.; A. J. Galvin, 343 The Arcade, at $28,200; Ferris Ave., E. 123rd to E. 131st Sts., to Stevens & McKeon, 343 The Arcade, at $5,980. Work involves 1,660 ft. 4-in. egg shaped rein. conc. and 3,110 ft. vitr. pipe, 1,800 ft. 2-in. E and C tile blocks, etc.

O., Cuyahoga Falls—Wm. H. Hunt Sons, Akron, O., awarded contract for 15,000 ft. vit. pipe sewer; 15,000 cu. yds. excav., 32 manholes, at $32,745.

O., Xenia—City let contract for bldg. sewer extension in Dists. 1, 2, 3, 5 and 6, to J. C. Mercer & Son, Piqua, at $28,628.

Pa., Philadelphia—A. Jafolla, awarded contract for constr. of new sewer in Octalaune St., at $190,000; J. McHugh, contr. for constr. of branch sewer in Olney Ave., at $30,000.

Pa., Pittsburgh—The Foundation Co., Pittsburgh, awarded contr. for bldg. pump house and suction tunnel for Carnegie Steel Co. at its Mingo plant at Mingo, on Ohio river, at $100,000.

S. C., Chester—Hucker & Laxtor, Charlotte, N. C., awarded contract to install sewer system on mill property at $28,000.

S. C., Hartsville—Howerton-Tinsway Co., Asheville, N. C., awarded contr. to extend sewer system; construct 9,800 ft. 8 and 10-in. sewers, at $34,228.

Wash., Spokane—Miller & Paulsen, local, awarded contracts for installing sub-trunk and lateral sewers on Maxwell Ave., at $16,715.

Wis., Kilbourn—Henry E. Wolff, Winona, Minn., awarded contr. for Sand Rock tunnel, outfull pipe sewer and lat. connections, at $30,000.

Wis., Milwaukee—Knowles & Febr. 314

EDITORIALS

ADVERTISING SIGNS ON PUBLIC HIGHWAYS

Among many highway officials there is a deep-seated dislike and open hostility to advertising signs on public highways and this feeling is undoubtedly shared by many users of the highways. Certain aspects of this matter merit attention.

Recently the chairman of a County Board of Supervisors issued the following notice to the merchants of the county: "All advertising signs on Primary and Secondary roads in this county must be removed on or before the first day of August, 1920, or same will be torn down by the county."

Two counties in the state have taken this action at this time and every county in the state is being urged to take similar action by the State Highway Commission, we infer from an article on the subject published recently in the Service Bulletin of the Commission.

The officials of one county asked the Attorney General of the State if they had the right to tear down the signs and his office ruled that their right to do so was beyond dispute. In substance the ruling was: That a public highway from side to side, and from end to end, belongs to the public, and an obstruction need not entirely block traffic to become subject to removal. It is classed as an obstruction if it is an impediment or hindrance which tends to interfere with free passage along the highways. Further, no person has a right to appropriate a part of the highway by using it for the posting of signs or advertising matter.

To quote from the Service Bulletin: "The Highway Commission in 1913 put the ban on the advertising sign on bridge and culvert structures and frowned on its use on any part of the right of way. From time to time various counties have issued orders forbidding the erection of such signs. Recently on federal aid projects it has ordered all signs torn down. Public sentiment seems now to have reached the point where the more general action started by (the two counties) backed up by the action of the Attorney General's office, may become effective in starting a final effort to drive this nuisance entirely off the right of way. There is still no way to prevent the erection of signs on the private property adjoining the highway. Only public sentiment and the right spirit of the private land owner can prevent this. Here's to (the two counties) and may every county in the State follow in their footsteps!"

With respect to the foregoing we offer the suggestion that the counties, in acting in this matter, have need of a sign reading: "Watch Your Step."

That advertising signs on the public highways are often unsightly is not denied. Sometimes they obstruct the view on curves and very often they confuse the tourists in their precise but inaccurate mileage markings. They probably do, at times, constitute obstructions to a free passage along the highways, while at other times they aid it. The problem is one calling for regulation, however, rather than prohibition.

It is well for highway officials to bear in mind that these signs are paid for by worth-while people; the sort of people who count in every community. Local merchants have used roadside signs since memory runs not to the contrary and it remained for the newspapers to discover all the unlovely aspects of billboards and outdoor sign advertising. The newspapers were not moved to prolonged outbursts against advertising signs, however, until national advertisers began to make use of them. Then all the bad things about the signs became apparent to the newspapers, all but one of which were discussed for the edification of newspaper readers. The point reserved was that every dollar spent on an advertising sign was being diverted from the potential income of the newspapers. There have been many newspaper editorials written to discourage the use of billboard and outdoor sign advertising, ostensibly to safeguard a variety of public interests, but actually to increase newspaper advertising revenue. Quite likely the users of advertising signs appreciate this fact and it may irritate them to see highway officials playing the newspapers' game, whether innocently or not.

In the great highway movement the support of local merchants is invaluable. Let us not place this support in jeopardy by arbitrarily ruling all advertising signs off the highway while expressing regret that they cannot be removed from adjoining private property at the same time.

As we have suggested there is need for censorship of highway sign advertising, but we doubt the wisdom of prohibiting the use of all such signs without respect to the location, nature and appearance of the individual sign. Some advertising signs are useful to the tourist, either wholly or incidentally, and they should not be removed without specific cause. Some signs are actually ornamental for even the face of nature is not beautiful in all its features.

CO-OPERATION IN TRANSPORTATION

The keen edge of cut-throat competition in transportation has been dulled. We refer, of course, to competition between the various forms of transportation rather than to that between carriers in the same class. Even the steam railroads seem anxious to show themselves friendly and to conduct their affairs in a neighborly manner. All this was very evident at the recent meeting called in Akron by the Federal High-

way Council. While primarily this was a national good roads conference it was attended also by representatives of steam and electric railways, waterways and express companies. In sending their representatives to this conference the managers of the other forms of transportation signified their willingness, for the present at least, to co-operate with highway interests in the coordination of transportation agencies. The conference was a veritable love feast with each interest anxious to commend and compliment every other.

Now, it is never our desire to take an ungenerous view of anything or anybody but we admit a long-standing and deep-seated distrust of the steam railway interests. Perhaps this feeling was gained in the service of three prominent railroad companies. At any rate we are quite sure that if any advantage accrues to other forms of transportation from the present tolerant attitude of the railroads it is well to realize all we can on this disposition toward cooperation, lest it be discarded for one of ruthless and destructive competition.

A prominent railway manager, speaking at the Akron meeting, expressed the opinion that rail transportation cannot be brought up to standard in less than five or six years from date. And even this accomplishment must rest largely on favorable circumstances and generous treatment.

Such being the case, highway interests have five or six years in which to operate unopposed by railway interests. Let no one doubt if the railway managers ever begin to feel highway competition they will oppose the highway movement with every force at their command. And the railways can, on occasion, muster a very formidable war machine as every initiated person knows. (It wasn't an accident that waterways went out of fashion for many years.) Just now the railroads stand, hat in hand, protesting their good character and good intentions and asking for one more chance. Perhaps it is very unbecoming in us but we confess that their present attitude persistently reminds us of: "The devil he got sick; the devil a saint would be. The devil he got well; the devil a saint was he."

Viewing the history of railway operations, off the right of way, as charitably as one will, a truly Elizabethan genius for dissimulation is disclosed at many points. Just now the railroads are, in a manner of speaking, under parole and they want to be very, very good. However, such are the imperfections of the world that it might, conceivably, come about well within the next ten years that they would consider it expedient to oppose the further development of the highways. If there is anything in this prospect it behooves the highway workers to make all possible progress during the period of minimum political opposition, especially in matters of legislation and taxation.

INSPECT THE OLD BRIDGES

A great deal has been written of late years about the effect of modern motor traffic on roadways and it is quite as important to realize that modern traffic is subjecting many existing bridges to stresses much greater than were provided for in the original design. Only the liberal factor of safety used in bridge work has prevented many serious bridge failures under the very common heavy live loads of today. Many bridges are in service which were designed to carry light, horse-drawn vehicular traffic and a concentrated traction engine wheel load. Subject such a structure to a full load of heavy truck traffic and a dangerous situation is produced; a situation dangerous alike to life and property:

In a timely contribution to this issue an engineer calls attention to this very real danger and cites specific examples of the danger inherent in loading old, badly deteriorated structures with loads greatly in excess of what the bridge was designed to carry when new. New flooring systems, being a part of the roadway, have been put in to serve modern traffic needs and these nearly always add to the dead load to be carried.

There is need of alertness with respect to old highway bridges. Let us prevent failure by anticipating them. Any bridge built for the lighter traffic of former times and now called on to carry present day loads should be looked upon with suspicion until a competent bridge engineer inspects it and pronounces it safe. Bridges on state highways are undoubtedly being looked after by the bridge engineers of the state highway comissions and it is only fair to assume that bridges in the large cities are also being checked up. But there are many bridges in villages and small towns on which outside talent must be engaged for the sake of safety.

BRICK PAVEMENT SPECIFICATIONS

Designers and builders of brick pavements are very appreciative of the specifications for brick pavements on city streets and county highways recently issued in convenient form by the National Paving Brick Manufacturers Association. Engineers especially appreciate the compliment to their skill and the deference to their judgment and prerogatives which are silently but eloquently expressed in the form in which the specifications are issued, for types of brick pavements are not specified. Instead, the component parts of brick pavements of all types are treated separately and the engineer is offered a specification for each part. In designing he is left free to combine these parts to form a complete pavement structure such as he deems suitable in the light of local conditions and requirements. The work reflects the modern practice in brick pavement construction. It is a manual of recommended practice. It is not offered to the profession as an expression of finality, for developments in the art are always in prospect, but it unquestionably records the advanced thought on the subject. This is not the place for an extended review of the work but it impresses us as of such character and quality as to merit special commendation. We have had unusual pleasure in adding it to our library.

Design and Construction of Brick Roads in Reno County, Kansas

By M. W. Watson, State Highway Engineer, Topeka, Kans.

When the word Reno is mentioned the mind usually pictures that far western city where the troubles of married life are easily cast aside. To the road-building industry of Kansas this word has an entirely different meaning. We at once think of a certain county located in the broad Arkansas river valley just west of the sixth principal meridian, slightly rolling and having a sandy loam soil. It is one of the largest wheat growing counties of the state, which usually outranks the other forty-seven states in the production of this very esential food product. The mineral resources of the county should not be overlooked, for within the county is located one of the largest salt mines in the middle west. Hutchinson, the county seat and principal city, is often termed the Salt City of the West.

Reno County Has 74-Mile Brick Road Program

The progressive farmers and business men of this county decided that the one thing necessary to its advancement was the construction of a system of real hard surfaced roads. They took advantage of the Benefit District law and formed districts for the improvement of 74 miles of road with a brick surface. To date the contract has been awarded covering 37.55 miles of 18 ft. monolithic brick. The remaining miles are ready to be let as soon as conditions will permit.

Like a large part of the Arkansas river valley this county is underlaid with fine gravel and sand. There is no stone suitable for road building found in the county and the difficulty of securing adequate transportation for shipping materials renders it necessary to untilize local gravel.

Design Features

The road from Hutchinson northwest through Nickerson,, being located through a very sandy loam soil, offers exceptional opportunity for drainage and a uniform subgrade. For this reason the base was designed to be 3½ ins. thick on the sides and 5½ ins. in the center, using a 3-in. vertical fiber brick as a wearing course. On the remainder of the work the base is designed ½ in. thicker than on project 15. The type of construction selected is monolithic brick.

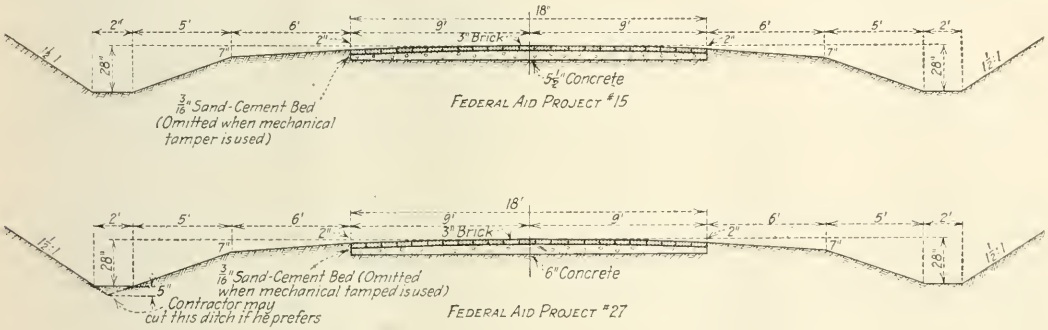


FIG. 1. TYPICAL CROSS SECTION OF RENO COUNTY, KANSAS, BRICK ROADS.

The concrete base is specified to have a mixture of one part cement, three parts fine aggregate and five parts coarse aggregate, or in the event a combined aggregate is used the mixture must give an equivalent strength to a 1:3:5 mix. The strength of a 1:3:5 mix is fixed according to the joint committee recommendation at 1,600 lbs. per square inch in compression. After extensive tests the following table of proportions was devised for use as the equivalent mix, everything passing a ¼-in. screen being considered as fine aggregate and all retained as coarse aggregate.

FIG. 2. PUMPING PIT GRAVEL FOR USE IN CONCRETE BASE FOR BRICK HIGHWAY IN RENO COUNTY, KANSAS.
FIG. 3. GRAVEL SCREENING PLANT USED ON RENO COUNTY WORK.

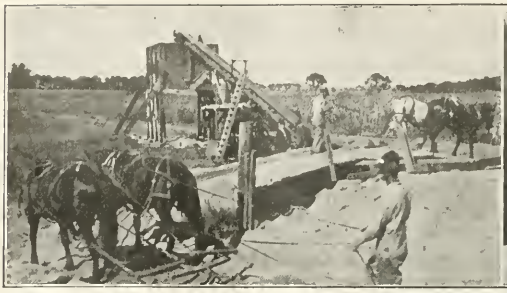


FIG. 4. LOADING GRAVEL ON RENO COUNTY WORK. FIG. 5. PARRISH TEMPLATE USED ON CONSTRUCTION OF RENO COUNTY MONOLITHIC BRICK PAVEMENT.

Per cent. of gravel retained on a ¼-in. screen.	Proportions by loose volume. Cement	Gravel
0 to 10	1 to	4
10 to 15	1 to	4½
15 to 25	1 to	4¾
25 to 35	1 to	5
35 to 45	1 to	5¼

The bulk of the coarse aggregate passes a 1-in. screen.

Construction

In the beginning of the work the base was poured at a stiff consistency and struck off by the Parrish type of multiple steel template, using a 3/16-in. dry sand-cement bed. The brick were laid direct on the sand-cement bed before the base attained its initial set. The gravel aggregate, containing very little coarse material, produced a concrete with which it was difficult to obtain satisfactory results. When mixed sufficiently dry to permit the other operations it contained too little water properly to saturate the dry cushion, with a consequent separation between the base and brick surface. When made with enough water to give the dry cushion a proper amount of water, due to the absence of coarse material, the concrete had little stability, rendering the operations of rolling and grouting exceedingly difficult and making it almost impossible to secure a smooth surface. This trouble has been overcome by the use of a mechanical tamping machine operated directly on the base and the elimination of the sand-cement cushion. A marked improvement is noted by reason of this change. Rolling is done by means of a hand roller and the joints are grouted with a 1 to 1 mortar in three applications.

CONTRACT PRICES ON BRICK ROADS IN RENO COUNTY, KANSAS

Items	PROJECT NO. 15 SECTION A	B	C	PROJECT NO. 27 SECTION A	B	F	G
Contractor	Stamey & Mackey Cons. Co.	Stamey & Mackey Cons. Co.	Wheeler & Keleher Cons. Co.	Wheeler & Keleher Cons. Co.	Wheeler & Keleher Cons. Co.	Stamey & Mackey Cons. Co.	Stamey & Mackey Cons. Co.
Contract Awarded Date	Oct. 10, 19	May 12, 19	May 12, 19	Oct. 10, 19	Oct. 10, 19	Oct. 10, 19	Oct. 10, 19
Mileage	7.093	5.481	4.997	5.004	5.520	5.014	4.443
Average Haul (Miles)	½	1½	1½	2	4	8	8
Excavation in Earth	$0.80	$0.60	$0.70	$0.97	$0.85	$0.75	$1.00
Borrow in Earth	0.60	0.50	0.60	0.60	0.60	0.60	0.60
Monolithic Brick	3.85	1.40	1.30	3.92	4.15	4.30	3.75
Class A Concrete	35.00	15.00	10.00	35.00	35.00	35.00	30.00
Reinforcing Steel	0.07	0.06	0.10	0.07	0.07	0.07	0.07
Lin. Ft. Guard Fence	1.10	.....	.....	.....	.....	.....	.....
Small Trees	.....	2.00	1.00	.....	.....	.....	.....
Large Trees	.....	10.00	10.00	.....	.....	.....	.....
Rods of Hedge	.....	4.00	2.00	.....	.....	.....	.....
Section Markers	.....	45.00	45.00	.....	.....	.....	.....
Stumps	.....	10.00	5.00	.....	.....	.....	.....
Raising Bridge Floor	400.00	.....	.....	.....	.....	.....	.....
Handrail Concrete	.....	.....	.....	40.00	40.00	35.00	45.00
Cost Slab, per mile	$40,873.00	$32,110.00	$33,095.00	$37,426.00	$43,962.00	$45,407.00	$39,774.00
Cost of Job, per mile	$47,998.00	$35,658.00	$37,335.00	$45,446.20	$50,942.26	$57,895.00	$46,131.00

Materials furnished by County. Cost of following Unit Prices not included in this price. Brick F. O. B. Plant @ $0.98 per Sq. Yd. Freight rate 9½c per 100 pounds. Cement F. O. B. Plant @ $2.50 per bbl. Gross Freight rate 12½c per 100 pounds. Gravel @ 25c cu. yd. in Pit.

FIG. 6. LAYOUT OF RENO COUNTY MONOLITHIC BRICK PAVING JOB SHOWING USE OF TEMPLATE, STEEL SIDE FORMS AND GRAVITY BRICK CONVEYOR.

No expansion joints are used and all construction joints are reinforced with ½-in. bars, 12 ins. center to center, in order to reinforce these points, which are believed to be weak points in the base construction.

An inspector is kept both in front and behind the mixer. One is employed continuously to check the proportioning of the concrete, which is varied continually to furnish the proper mix. The gravel is pumped and screened to remove a portion of the fine aggregate before loading, but the disposal of surplus fine material is considered to be in excess of the extra cost of cement required.

The names of the contractors and contract prices for the different projects and sections are indicated in the accompanying table.

Payment

Federal aid has been granted on the sections awarded at the rate of $15,000 per mile. After deducting the amount of federal aid for each district, the cost will be distributed 50 per cent to the county, 25 per cent against the townships in the benefit district, in proportion to the land of the district in each; the remaining 25 per cent is charged to the property in the benefit district, according to the benefits accruing.

U. S. TESTS SHOW ROAD WEAR AND RESISTANCE

Such important questions as how hard a heavy motor truck pounds a pavement when going at five miles an hour and at 15 miles an hour are being answered by investigators for the Bureau of Public Roads, United States Department of Agriculture, in a series of scientific experiments, which, when completed, promise to be of great value to highway engineers. Already sufficient tests have been made to show that increased speed of a vehicle equipped with hard rubber tires tremendously increases the impact which its wheels make on the roadway where there is any unevenness. On the other hand, where pneumatic tires are used increased speed adds comparatively little to the impact. It has been suggested that these tests will be of great value not only in settling questions of design but may also lead to a rational basis for determining license fees for motor vehicles.

Trucks have been used in these tests varying in size from a 1-ton truck up to a 7½-ton truck carrying an excess load. Each truck was run over a special recording device embedded in a roadway and the impact which resulted when one of the wheels made a 2-in. drop from a ledge built in the surface caused the deformation of specially prepared copper cylinders forming part of the apparatus. The magnitude of the blow was accurately ascertained in pounds by measuring the extent to which the cylinder had been forced out of shape.

Tests Show Value of Pneumatic Tires

Recent tests were made with a 3-ton truck of well known make loaded with a 4½-ton load so that the total weight on each rear wheel was 7,000 lbs., the unsprung portion (that not supported by the springs) being 1,700 lbs. and the sprung portion (that portion supported by the springs) 5,300 lbs. The truck was equipped first with an old solid tire that had been worn down to a thickness of 1 in. Then, with exactly the same load on the truck, a wheel was used fitted with a new solid tire 2½ ins. in thickness. And finally, the truck was equipped with pneumatic tires 42 x 9 ins. and blown up to a pressure of 142 lbs. per square inch. The following table shows very clearly the bad effect an old tire is likely to have on a road surface and the greatly lessened impact produced by trucks when they are equipped with pneumatic tires. The tests show that as the vehicle's speed increased the impact from the old hard rubber tire increased greatly. The impact from the new hard rubber was somewhat less.

Approx. Speed	Height	Old Tire	New Tire	Pneumatic Tire
5.7	2 ins.	11,600	9,400	7,100
10.2	2 ins.	18,500	14,100	7,800
14.6	2 ins.	26,500	18,700	8,300

Testing Paving Slabs

Related to these tests is another series which utilizes the figures secured in the first experiments. A number of paving slabs were tested by means of a machine designed to give impacts equivalent to those produced by the rear wheel of the heavy truck already referred to. The unsprung portion of the weight of this machine is 1,500 lbs. and the sprung portion weighs 6,000 lbs. The tests were made by raising the entire weight through a height of ⅛ in., allowing it to fall 500 times, then to a height of ½ in. with 500 repetitions, then ⅜ in. more in height, and so on until the slab failed. To date about 12 slabs have been tested, laid on a rather wet subgrade. A surprising difference has been found in the strength of the different types of pavements tested. The total number of blows required to cause failure have varied with the different slabs from 67 up to almost 2,000. All these data promise to be of the greatest value to engineers in selecting material for roads of various types.

Relative Wear of Different Pavements

The Bureau of Public Roads is also making a study of the relative wearing qualities of different types of pavements and tests have been about completed on a short section of pavement containing 49 different types subjected to the wear of a special truck equipped with five large cast-iron disk-like wheels. The relative wearing qualities of hard as compared with soft brick are brought out very distinctly in this test. The resistance to wear of various kinds of stone block sections is also shown up to good advantage. A chance to compare grout and asphalt fillers for both brick and stone block is furnished by this investigation. Likewise, the relative wearing qualities of concrete when mixed with various kinds of coarse aggregates is indicated.

Investigation of Subgrade Materials

The investigation of subgrade materials, started a few months ago with the co-operation of the District engineers and State engineers, is proceeding at a very satisfactory rate. A number of samples have been received from various parts of the country and laboratory analyses of many of these samples are partially completed. The methods being used by the Division of Tests will shortly be published as a paper so that any other laboratories wishing to conduct similar investigations may have

some guide as to the method of procedure being followed by the Bureau of Public Roads.

The samples analyzed have been taken from parts of the roads that have failed very badly as well as from adjacent parts of the same roads that have withstood heavy traffic successfully. It is hoped that by a comparison of the laboratory results on these samples with the reported behavior of the road in service differences in the subgrade materials will become apparent so that we will be able to say what physical characteristics soils must possess to give them high bearing value.

ILLINOIS SOCIETY OF ENGINEERS ANNOUNCES PRIZE TECHNICAL PAPER CONTEST

A prize technical paper contest, open to those who have been members of the society for not more than five years and to applicants for new memberships, has been announced by the Illinois Society of Engineers. Rules governing the contest are given herewith. Five cash prizes of $25 each will be awarded. The contest has been arranged as a part of the plan designed to make the Society of tangible interest and value to its members.

Rules and Information

1. The contesting author must be a member, or affiliated member, of the Illinois Society of Engineers for not more than five years on Jan. 1, 1921. Applications for membership in proper form submitted before Nov. 15, 1920, shall qualify contestants.

2. The papers may be on any technical subject naturally falling under one of the five following general divisions:

A. Drainage.
B. Roads and Pavements.
C. Sewerage.
D. Surveying.
E. Miscellaneous Civil or Municipal Engineering.

The contesting author shall indicate at the top of the first page of his paper in which of the five divisions he wishes to compete, but the judges shall have the right to classify it in another division if in their opinion it seems proper to do so.

3. A prize of $25 in cash and a certificate of merit will be awarded to the best paper in each of the five divisions —a total of $125. If in any division there are submitted two papers of equal merit, in the opinion of the judges, an additional prize will be offered.

4. A contestant may submit papers on more than one subject, but no contestant will receive more than one prize.

5. The length of papers shall be not less than 1,500 nor more than 2,500 words exclusive of illustrations and tables.

Papers Must Be Submitted by Nov. 15, 1920.

6. Each paper shall be sent by registered mail to E. E. R. Tratman, Secretary, Wheaton, Ill., on or before Nov. 15, 1920. Papers shall be typewritten on one side of plain paper (no letterhead) and shall not be signed.

7. Enclosed with the paper shall be a plain sealed envelope containing the full name and address of the contestant and the title of the paper.

8. The Secretary will place a key number on each paper received and submit them to the judges. The author's name will not be divulged until the decision of the judges has been reached.

9. The decision of a majority of the judges in making an award and interpreting the rules shall be final.

10. Rights of publication of all papers submitted is reserved by the Illinois Society of Engineers.

11. Prize winners will be announced and papers read at the annual meeting in Chicago, Jan. 26-28, 1921.

The Judges

The following have consented to act as judges in the contest:

Arthur N. Talbot, Professor of Municipal and Sanitary Engineering, University of Illinois; Edgar S. Nethercut, Secretary, Western Society of Engineers, and Samuel C. Hadden, Editor, Municipal and County Engineering.

THE REPAIR OF MUNICIPAL BRIDGES

By A. W. Consoer, of Consoer Engineering Co., 1654 Monadnock Block, Chicago, Ill.

It has frequently happened that bridge repairs, involving the replacement of a plank floor with a heavier type of floor, or even more extensive alterations have been attempted by municipal officials without securing engineering advice and with an utter disregard for the violation of certain basic principles of bridge design. The writer's firm was recently retained by a municipality to report on a bridge which was showing alarming evidence of structural weakness, and had been closed to traffic by the Village Board, pending an investigation, as it was quite apparent to even a casual observer that the bridge was a menace to the traveling public.

An Example of a Dangerous Bridge

The steel superstructure of the bridge consisted of three 74 ft. through Pratt Truss spans of five panels each, with an 18 ft. roadway and two 5 ft. sidewalks. The investigation showed that some six years previously an old plank floor had been replaced by an enterprising contractor with a floor made up of a concrete base, sand cushion, and creosoted wood block wearing surface. An examination of the roadway stringers showed that many of them had taken a permanent set. The concrete base was of exceedingly poor quality, and showed serious evidence of disintegration. The creosoted wood block floor had buckled in several places and there was real danger of the floor breaking through under the impact of a fast moving automobile or truck. In view of these facts the bridge was kept closed to vehicle traffic by erecting barricades and by removing part of the floor at each end of the bridge to make impossible the use of the bridge for vehicle traffic.

The plank floor for which the structure had been originally designed weighed approximately 14 lbs. per square foot, while the new floor weighed about 100 lbs. per square foot. The new floor had been installed upon the advice of the contractor, who was building a similar floor on a new bridge about a mile upstream. An analysis of stresses showed that with the creosoted wood block floor, the roadway joists could carry only a 3-ton motor truck

load without exceeding a unit tensile stress of 16,000 lbs. per square inch, and with no allowance for reduction of section due to rust or corrosion.

Repairing the Dangerous Bridge

Inasmuch as funds for the construction of a new bridge could not be obtained, certain repairs were recommended which would modernize the bridge to the extent of making it capable of carrying a 15-ton load or a uniform live load of 65 lbs. per square foot over the entire roadway and both sidewalks. The repairs included replacing the existing roadway joists with seven lines of 9 in. 21-lb. I-beams and two lines of 9 in. 5 lb. channels, riveting flats on the bottom flanges of the end posts and top chords to eliminate the effects of pin eccentricity, a thorough cleaning and painting of all steel work, and the construction of a new and lighter bridge floor, consisting of creosoted ship-lap and a 1 in. bituminous wearing surface.

There is every possibility that this bridge will be called upon to carry concentrated loads of 10 to 16 tons. The possibility that this structure will ever sustain a live load exceeding 65 lbs. per square foot over the roadway and sidewalks is decidedly remote, so that it seemed justifiable to proceed with the repairs outlined, although modern designing practice would prescribe a uniform load of at least 100 lbs. per square foot for a bridge of this type.

Investigate Effect of Modern Loadings on Old Bridges

Many bridges are still in service in prosperous municipalities that were designed to carry light horse drawn vehicles. In checking a number of old steel bridges for municipalities, it has been found that most of them are designed for a gross concentrated load of not to exceed 5 tons. Heavy motor truck loads as high as 18 tons are becoming more and more common in all villages and cities, particularly on routes of improved state highways or marked trails. The various state and county highway departments have succeeded in replacing many light, flimsy steel highway bridges with modern bridges, designed to carry present-day loadings, but there remains a large field of work in the repair or replacement of municipal bridges. Wherever possible new structures should be built, but where funds are limited, repairs should be made to reduce as far as possible the hazard from fast moving motor truck traffic. Where the repairs do not bring the capacity up to 15 tons (or other maximum load prescribed by statute) warning signs should be erected at each end of the bridge, giving the permissible loading.

Strengthening Old Bridges

It is frequently possible in the case of an old steel bridge to strengthen the floor system so as to carry heavy concentrated loads. The increased weight of the new floor system will, however, reduce the allowable uniform live load, but in many cases the truss systems will still be good for a live load of about 50 to 70 lbs. per square foot. To make such repairs is often justifiable as heavy concentrated loads are carried each day, while the uniform live loading is seldom realized, even in large cities. It is, of course, necessary to determine that the truss systems will carry the same concentrated loads that the new floor system is designed for.

Repairs or strengthening of old steel bridges should be undertaken only after a careful examination and stress analysis have been made. It is necessary to measure not only main dimensions and sizes of members, but dimensions and sketches of all details must be obtained as well, as it is frequently found by calculation that the strength of a certain connection or detail is the limiting factor in the load capacity of the structure. It is necessary also to make an estimate of the per cent loss of strength by corrosion of the various members and details of the bridge. Among other things it is important to note the position of pins with respect to the centers of gravity of connecting bridge members. As in the case mentioned above, it has frequently been found advantageous to eliminate the effect of pin eccentricity in the end posts and top chords of old steel bridges by riveting flats to the lower flanges of the channels.

The strength of a riveted connection in one case was increased by removing $\frac{5}{8}$-in. rivets one at a time, reaming out the holes, and driving $\frac{3}{4}$ in. rivets. In another case the strength of an I-beam floor beam was increased by riveting cover plates to the upper and lower flanges. A plate girder floor beam was converted into a truss by using two $1\frac{1}{2}$ in. rods for the lower chord and short I-beams for posts. In still another case it was found that the roller bearings at one end of a span were so jammed by accumulations of rust and dirt, that no movement could occur in warm weather, thus causing high temperature stresses. New end bearings were installed, and the space around the shoes was enlarged and arranged so that it would drain.

Not only the superstructure but the substructure also should be carefully investigated. It is sometimes desirable to replace the substructure and strengthen the superstructure, or it may be practicable to renew only the superstructure if the substructure consists of substantial masonry piers and abutments on good foundations. It is often a difficult matter to determine the condition of masonry piers and their foundations. A novel method was employed some years ago in the case of a bridge over the Illinois River at La Salle, Illinois. It was contemplated to build a new superstructure on the old piers and abutments, but there was considerable doubt as to the exact condition of the substructure. A well driller was hired to drill down through the piers. His operations disclosed the fact that the bottom of the masonry was some 12 ft. above river bottom, and that the stability of the piers was depending on the pile foundations, and the plan to use the old substructure was therefore abandoned.

File Corrected Original Drawings

A set of the original drawings of a bridge under investigation is a great help. It is seldom that any can be located, and if they are available, they must be used with caution, as frequently changes were made during construction which are not recorded on the plans filed.

ADVANTAGES OF SIPHON SPILLWAYS

By A. T. Mitchelson, Senior Irrigation Engineer, U. S. Department of Agriculture, Washington, D. C.

(Editor's Note: The following presentation on the advantages of siphon spillways is from Bulletin No. 831, issued under date of August 25, 1920, by the U. S. Department of Agriculture, entitled: Spillways for Reservoirs and Canals. The bulletin has chapters on: Spill-

ways, Overflow Spillways, Spillway Control, Flashboards, Sliding Gates, Tilting Counterweighted Gates; Rolling Dams or Barriers, Siphon Spillways, U. S. Reclamation Service Siphons, European Practice and the Huntington Lake Siphon Spillway. The Bulletin assembles, as fully as practicable, all the best information available in such a way as to be of use to anyone interested in the subject. Only the author's conclusions are here presented.)

It is the intention of the writer to point out, in as brief a manner as he can, the advantages of the siphon spillway when it is desired to facilitate the escape of high flood crests, and at the same time to conserve crest length, and cost of construction and maintenance, by eliminating the use of mechanical or other energy necessary to operate partially or completely automatic spillways of other types.

It is not too broad a statement to say that the siphon is the only absolutely "foolproof" method of maintaining adequate spillway capacity without the addition of moving parts to be constantly cared for and frequently replaced, and which very often fail to operate automatically or because of the absence of an intended operator.

Furthermore, the siphon permits of (1) closer regulation of the pond level, (2) the heightening of the spillway crest and therefore additional storage capacity where each unit of height is of greater value, (3) the coming into full and efficient action almost at the moment the danger point is reached, instead of having to depend upon additional danger-producing head to increase discharge, and (4) maintaining the desired pond level by quickly ceasing to act when the danger is passed.

It is evident that having provided adequate spillway of the siphonic type in about one-half the area required for any other known automatic type, the escaping water is concentrated to a narrow jet. This allows a more economical arrangement of the channel intended to neutralize the accelerated flow and convey it to a natural drainage course.

The writer has never heard any question raised as to the possibility of damage to land or structures below the point of installation of a siphon spillway, but it has occurred to him that such possibilities do exist and that provisions may be considered to counteract such damage. The spillway of a reservoir may be called upon to discharge a large volume of water.

In cases where ordinary overflow spillways are operating, the water released and allowed to continue down the watercourse would increase and decrease with the head on the overflow, and would at no time during the discharge be greater than the volume of water contributed to the reservoir above the structure. The watercourse under such conditions would be performing its natural functions.

In the case of an ordinary siphon spillway, from the instant the siphon comes into action the volume in the channel below the structure becomes the full spillway capacity and the burden of conveying this suddenly imposed surplus may be compared to that of a similarly released flood; this for the reason that the spillway capacity is usually assumed to care for both normal and flood flow into the reservoir.

A battery of siphons may be regulated so as to bring each unit into action separately or in pairs by placing their crests and air intakes at different elevations. The regulating parts are usually placed near the high-water line of the reservoir, where flow into it results in a slow-rising water surface.

Varying the elevation of the priming parts of the different units need not utilize a range of more than from 1 to 2 ft. in height, while it would regulate the outflow to conform more closely to the conditions of an ordinary overflow spillway and the volume released to the watercourses below the dam would vary with the reservoir inflow.

The lower unit should be fixed to operate at the level where it is desired to maintain the reservoir surface, and the remaining units should have their crests and air intakes set to operate at slightly higher elevations—still maintaining a safe freeboard above the highest air vent.

The writer is of the opinion that this practice has been followed on several of the larger installations, but for the purpose of regulating the pond level and not to govern the discharge to the stream below.

There are conditions where the siphon spillway is not adapted to the site or to the requirements which it is intended to serve, and its failure to perform under the improper conditions has led to condemnation of the structure as a type. For instance, one case cited in a criticism to the writer, refers to the tendency of a siphon to check the velocity of the stream near its intake and encourage the deposit of silt in front of the structure, where it was used as a regulator at the end of a canal. The design of this siphon did not take into consideration its utilization as a scouring device, but was intended only to skim the surface water and prevent the overflow of the banks of the canal. Some provisions should have been made temporarily to take care of the silt problem, since it was intended, as an ultimate development, that a power plant would be located near the site of the siphon and its installation was never intended for other than regulatory purposes. It may be stated that any other non-automatic method of control would have presented the same objections found in this case.

Another case where the siphon was condemned as a failure proved to be its attempted use as a series of "drops" on a canal system, and the principal objection in this instance was its failure to deposit the water from the upper to the lower channel in a vertical rather than a horizontal direction, necessitating more protection to prevent scour below the structure.

It is agreed that the use of a siphon as a substitute for the ordinary overpour drop would conserve area and in addition would deliver vastly more water to the lower level per unit of cross section, but it would also produce a velocity at the outlet so much greater than the velocity developed over an overpour drop that some method of destroying the energy of the rapidly falling water must be provided. It is not evident, however, why the water should not emerge from the siphon in vertical direction as it does in an ordinary drop. It is the opinion of the writer that the use of the siphon as a drop is another case of applying the principle to a foreign use without taking the necessary precautions to provide for its primary factor—accelerated velocity.

It is hoped that in the near future the more complete study of the structure as a standard design for different forms, conditions, and efficiencies will develop data to permit of its extended use.

TRANSMITTING ELECTRIC CURRENT TO SMALL KANSAS TOWNS

By F. H. Frauens, Jr., of W. B. Rollins & Co., Consulting Engineers, 208 Railway Exchange Bldg., Kansas City, Mo.

The use of transmission lines to supply electric current to small towns is increasing rapidly in all parts of Kansas, especially noticeable being the growth of municipally owned lines. For a number of years private concerns have been constructing high tension lines from large central stations and they have, in some sections, built up quite a net-work.

Of special interest, however, is the fact that many towns which have been operating small plants of their own, or have been without electric service, are beginning to see the advantage of high tension lines for reliability and flexibility of service.

When a reliable source of current is located within a reasonable distance and an equitable rate can be obtained, small communities can obtain 24-hour service and ample capacity for growing needs at rates less than the cost per kilowatt of operating a small plant, at the same time helping the plant from which energy is obtained reduce the unit cost of current by cutting down overhead expenses.

Small communities of even down to 100 or 200 population are demanding the comforts and convenience offered by electric current, and, while a few towns in isolated regions are installing storage battery plants of limited capacity, the tendency is to build for the future by constructing transmission lines to some neighboring plant where current can be obtained. We know of at least 35 towns where transmission lines have been built during the last year and several more where such lines are being planned. The time will come, of course, when some towns now operating a plant and supplying a number of smaller towns will themselves be supplied from a larger source, the lines now in use going to make up some of the many branches of a large net-work of lines.

Another advantage of the cross country line is the service that is furnished farmers, as electric current is doing a large share in the way of making life on the farm, both as regards fireside life and "doing the chores," more attractive. The determining factor in locating the route of a proposed line is often the location of the farms desiring to use the service to be provided.

Municipal Lines

As a general thing, municipal lines are fairly well constructed, and typical specifications for a line to supply a town of, say 500 population, would call for a 3-phase line of No. 6 copper wire or aluminum cable, on 6 in. x 30 ft. cedar poles, spaced from 26 to 35 poles per mile. Where the distance is not over 10 or 12 miles, a voltage of 6,600 is used, in many cases, however, the wire spacing and insulation being so as to provide for the use of higher voltages later on.

The rate charged for current depends of course on the size and type of plant supplying the current and varies, in the case of the majority of lines which this discussion covers, from 3 to 6c per kw., depending, however, upon the demand load. In one case, where current is obtained from a small municipal oil engine plant, the rate varies with the price of fuel oil, which is a neighborly method of doing business. As the loss in transmission and distribution is not over 25%, and usually less than this, current can be retailed at 10 to 15c, which allows interest on bonds and sinking fund to be paid.

The use of the out-door type of sub-station and equipment to make the operation of the consuming end of the line practically automatic cuts down both the first cost and the operating expenses. Switches operated by clock mechanism turn the street lights and white way systems on and off, so that outside of fuse burnouts and other accidents, the operation of the system is merely a matter of reading the meters and collecting the bills. There is very little upkeep, except tree-trimming, for the first 15 or 20 years, so that the services of some one to look over the line at intervals and to repair breakdowns due to storms, etc., is about all that is required.

Influence on Water Works Installations

A reliable and economical system of furnishing current for light and power also has a tendency to promote the installation of water works systems in small towns. Pumping by electricity is an attractive method, and, where the town is not burdened with a light plant that is a losing proposition, the citizens can usually see their way clear to own and operate a water works system.

One thing which has retarded the growth of transmission lines, especially as regards several towns of about the same size, has been town rivalry, or jealousy. Some towns were unwilling to build a line to a neighbor, because they thought that by so doing they were helping out a rival instead of developing home industry. We know of one instance where a town refused for some time to consider getting current from a neighbor for just this reason. The citizens would tell you emphatically that they certainly would not help support a light plant located anywhere but in their own town. Now, however, after a line has been built and in service for some time, the same boasting citizens will chuckle and say, "Good joke on our neighbor; why, we have them working for us over there 24 hours per day."

SOME FEATURES OF SMOKE REGULATION IN PITTSBURGH

By H. B. Meller, Chief of the Bureau of Smoke Regulation, Room 608 City-County Bldg., Pittsburgh, Pa.

Smoke is a product of incomplete combustion, and the fuel used under smoking stacks is usually bituminous coal.

When fresh fuel is thrown on a fire, the volatile matter, consisting mainly of compounds of carbon and hydrogen, is driven off. Any part of these gases which is at red heat or above before being mixed with a sufficient quantity of air, will give off particles of carbon. Should these particles of carbon be below their ignition temperature before they are brought into contact with oxygen, they will show while in the gases as smoke and as soot where deposited on a solid surface. In the absence of sufficient air, some of these particles will unite with the hydrogen in the gases to form marsh gas, whereas with the proper amount of oxygen, the hydrogen will unite with it to form

water vapor, while the carbon unites with oxygen to form CO2. Therefore, with sufficient supply of air a part of the gases will be completely burned to CO2 which gives 14,600 heat units per pound of carbon and part will be burned only to CO which gives but 4,500 heat units per pound of carbon, and part will go out as smoke, the solid particles being uncombined. Air which is too cold will chill the gases and part of them will pass off unburned.

The fixed carbon in the fuel unites with oxygen to form CO2 or CO as the case may be. The residue in the fire box if we assume complete combustion is ash.

The problem is to get the proper quantity of air into the furnace at the right time and have it mix properly with the gases as they are driven off. A big factor of course is uniform feeding of coal and air, as with mechanical devices such as stokers.

This will indicate the importance from an economical stand-point of securing as nearly complete combustion as possible; and it goes further back—either less coal would have to be mined and transported or the shortage at a given time would be less acute. All of which would help the industrial situation.

After the smoke gets into the atmosphere, it must be reckoned with mainly as soot. The soot fall in Pittsburgh for the period of April, 1912 to April, 1913, was calculated to average 1,031 tons per square mile. One need not be told what damage is done to buildings and contents by such precipitation.

Fogs and Clouds

The gases of the atmosphere hold in suspension considerable quantities of condensed water vapor which forms fogs and clouds, and solid particles including dust and soot and other residues of combustion. The formation of fog is hastened in a smoky atmosphere and such a fog, instead of being white, may be gray or brown or almost black and so dense as nearly to exclude sunlight. Such a fog is heavy and settles to the lower levels and its evaporation is slow, both because of the retarding effect of the tar-covered particles and the slowness with which the heat rays from the sun are able to penetrate and dissipate it. The greater the quantity of smoke, the more persistent are the fogs and the fewer the hours of sunshine. What sunshine there may be is less intense. Daylight is depleted. These effects depend of course upon the size of the city, the amount of smoke, the topography and the wind velocities.

In Pittsburgh, for example, which lies mostly in valleys and is surrounded by hills, and with low wind velocities, the fogs settle readily. A considerable part of the density of these fogs is caused by smoke which is driven in from territory contiguous to the city over which the Bureau of Smoke Regulation has no control.

Effects of Smoke on Health

I am indebted to Dr. R. G. Burns, Superintendent of the Bureau of Infectious Diseases of the Department of Public Health, City of Pittsburgh, for the following statement as to the direct effects on health of breathing a smoke-laden atmosphere:

> The general effects of a smoky atmosphere upon the health of the inhabitants of cities have been broadly summarized by Wainwright who states that smoke interferes with the welfare of a community.
>
> 1st. By conducing to the formation of fog and rain.
>
> 2nd. By shutting out sunlight, depriving us of certain qualities of light of great importance in regard to changes in organic matter.
>
> 3rd. By depositing soot, rendering houses and their contents dirty.

He states that the acid content of smoke and the irritating particles suspended in it are harmful to the membranes of the air passages whether these be in a healthy or other condition; that it adds to the discomfort of those suffering from heart disease, lowers the tone of the general health, is a peril to the aged, diminishe buoyancy of spirit as well as reducing resistance t disease.

That a smoky atmosphere predisposes toward fogs is a fact long known. Statistics show a sharp rise in the death rate following a fog period; especially is this true in respiratory diseases, according to Rollo Russdell, who states that while cold is doubtless a factor in raising the mortality during a fog period, the most potent cause lies in the smoke constituents of the foggy atmosphere. He states that great cold combined with fog in the country is not productive of much illness whereas in smoky towns it is different. In London, the death rate was raised in a fortnight from 27.1 to 48.1 per thousand; that the prevalence and fatality of acute respiratory diseases, were enormously increased and that the excess deaths totaled 2,994, and that at least 30,000 persons must have been ill from the combined effects of smoky fog and cold.

Authorities differ, some claiming a low temperature as the exciting cause, while others maintain that the mortality increase is due to the fog per se. Be that as it may, certain it is that the death rate from acute respiratory diseases increases.

Sohr and Rubuer believe that smoke predisposes to acute pulmonary tuberculosis. With this statement I am not prepared to agree, a compilation of deaths from pulmonary tuberculosis during the last decade in the ten largest cities of the U. S. shows the Pittsburgh rate of 105.6 to be the lowest and this in contrast with cities that are comparatively smoke-free.

Dr. White in his analytical study of the relation of smoke to pneumonia and tuberculosis in Pittsburgh where he states it is possible by virtue of its contours to separate the atmosphere into densly laden, moderately laden and comparatively no smoke areas, is forced to the conclusion that the smoke content of the air has an apparently important bearing on the pneumonia death rate and but little bearing upon the tuberculosis death rate. He further concludes that the death rate in the city of Pittsburgh is low, and that there is nothing in the smoke content of the air which in any way stimulates the onset of the tuberculosis process or militates against recovery from this disease when once contracted.

To sum up—if smoke is injurious to health then smoke plus fog is worse. That it irritates the air passages, predisposing to common colds, influenza, lobar pneumonia, acute bronchitis and the pneumonias incidental to measles and whooping cough, is beyond question.

If smoke were not injurious to health certainly the economic loss entailed would justify any and every

effort put forth for the prevention of such an obvious nuisance.

So far as the mental state is concerned, bright, sunshiny days undoubtedly have a tonic effect, while dark, foggy, smoky days are correspondingly depressing. It will be found that labor is less efficient on cloudy or smoky days.

Cost of the Smoke Nuisance

Now a word as to the cost in money of the smoke nuisance. John O'Connor, Jr., in an investigation conducted in Pittsburgh in 1913, reported that estimates of the annual loss per capita in Pittsburgh and other cities where the problem had been studied varied from $12 to $20. Mr. O'Connor tabulated his findings for Pittsburgh as follows:

1.	Cost to the smoke maker	
	(a) Imperfect combustion	$1,520,740
2.	Cost to the individual	
	(a) Laundry bills	1,500,000
	(b) Dry cleaning bills	750,000
3.	Cost to the household	
	(a) Exterior painting	330,000
	(b) Sheet metal work	1,008,000
	(c) Cleaning and renewing wall paper	550,000
	(d) Ditto lace curtains	360,000
	(e) Artificial lighting	84,000
4.	Cost to wholesale and retail stores	
	(a) Merchandise	1,650,000
	(b) Extra precautions	450,000
	(c) Cleaning	750,000
	(d) Artificial lighting	650,000
	(e) Department stores	175,000
5.	Cost to quasi-public buildings	
	(a) Office buildings	90,000
	(b) Hotels	22,000
	(c) Hospitals	55,000
	Total	$9,944,740

This brings us to Pittsburgh's experience in smoke abatement.

Experience of Pittsburgh in Smoke Abatement

Official cognizance of the smoke nuisance was taken as early as 1804. On June 10th of that year, the Burgess of Pittsburgh addressed a letter to the President of Council, uring that measures be adopted to remedy the nuisance. However, no legal regulation was attempted until shortly before 1869 when action was taken that "no bituminous coal or wood shall be used in the engine of any locomotive employed in conducting trains upon any railroad."

The discovery of natural gas and its utilization as a fuel practically freed the city for a time from smoke. In 1881, William Metcalf, an engineer and mill owner, estimated the cost of the smoke nuisance to be more than one million dollars a year. In 1884, Pittsburgh was using annually about three million tons of bituminous coal. With the introduction of natural gas this fell off to less than one million tons, but by 1890 the coal consumption again began to move upward and by 1895 smoke was again the great nuisance.

In March, 1892, the first general ordinance was passed making it unlawful for any chimney or smoke stack used in connection with a stationary boiler to allow, suffer or permit smoke from bituminous coal to be emitted or escape therefrom within a certain district.

A second ordinance was passed in May 1895, providing that the emission of more than 20% black or dark gray smoke from any stack should be considered a public nuisance. A decision of the Superior Court virtually made this ordinance inoperative.

Another ordinance was passed in December 1906 declaring the emission of dense black or dense gray smoke for more than 8 minutes in any one hour to be a nuisance and prescribing penalties for violation.

On March 3rd, 1911, this ordinance was declared void on the grounds that the legislature of Pennsylvania had likely not given the city any sufficient authority to pass ordinances on the subject of the emission of smoke and that the ordinance was unreasonable.

On June 6th, 1911, the Legislature passed an act authorizing cities of the second class to regulate the emission of smoke and in September, 1911, a new ordinance, the present one with one modification—that of the exception of mill heating furnaces and puddling furnaces—was passed. The present ordinance superseding this was approved Jan. 4, 1917, and provides that "No person or corporation shall construct, install, reconstruct, alter or repair any furnace, boiler-furnace, stack or other apparatus connected with stack, unless he or it shall make application in writing to the Bureau of Smoke Regulation on the form furnished by the said bureau, duly sworn to before a notary public, or any person authorized to administer oaths, for a permit for such construction, installation, reconstruction, alteration or repair and in and by such application shall give the plans and specifications, showing the style and dimensions of the furnace, boiler-furnace, stack or other apparatus connected with a stack intended to be used, a description of the building or part thereof in which such furnace, boiler-furnace, or other apparatus is located, including the means provided for regulating the temperature of such building or part thereof and ventilating the same, and generally all provisions made for preventing smoke together with a statement of the kind of fuel proposed to be used and of the operating requirements to be made of the furnace or furnaces referred to therein and unless such application shall be passed upon by the Bureau of Smoke Regulation, and approved in writing and a permit issued as hereinafter provided; provided, however, that minor or emergency repairs which do not increase the capacity of such furnace, or which do not involve any substantial alteration in such furnace, boiler-furnace, stack or other apparatus and which do not involve any alteration in the method or efficiency of smoke prevention, may be made without a permit."

Policy of Cooperation

Throughout the policy has been one of cooperation, and meetings of operators were called from time to time. The responses in general were prompt and sincere, the percentage of those who had to be forced into compliance being very small.

The keynote always has been the saving to be effected by securing higher efficiency from the plant. The following extracts from letters show that this was more than justified. Many of the men who at the beginning were active opponents or were at least apathetic became warm supporters when they found compliance, unwilling perhaps at first, saved them money.

Handling of Typical Cases

It may be of interest to know how typical cases would be handled by the Bureau:

(1) The Case of a Violator: The inspector will report a violation of the ordinance, which means that the density of the smoke issuing from the stack was No. 3 or greater for at least 2 minutes in a period of 15. If he is near enough to at once go into the plant, he will ascertain the cause of the violation and if possible correct it at the time stating that fact in his report. If he does not enter the plant, a letter is sent reading about as follows:

Notice of Violation of Ordinance No. 566.

This is the first notice of violation of Ordinance No. 566 for the current month and the —— notice for the current year.

It is not the policy of this Bureau to avail itself of the penalty section of Ordinance No. 566 where an immediate effort is made by violators to eliminate the cause for violation.

Information is desired, therefore, as to the cause of violation now reported to you and a statement as to whether such violation may be expected to recur.

If there is any information or advice which can be given by this Bureau or if the assistance of any of its inspectors will aid you, the Bureau will be very glad to avail itself of the opportunity to cooperate.

If remedial action is not taken and a second violation is reported, an inspector is detailed to make a report on conditions. Recommendations are prepared and the operating head of the concern is asked to call at the Bureau of Smoke Regulation where he is told what our recommendations are and asked to cooperate to eliminate the smoke. This, in nearly all cases, brings the desired result, although occasionally considerable prodding is necessary. If as has occurred, correction is not made by the operator, suit may be entered. This is a last resort and its application has been required in a limited number of cases. Sometimes it is necessary to give an operator considerable time to make the necessary changes and during such period violations must be more or less ignored, provided he is doing the best he can with the equipment he has. All cases of complaints received from residents are investigated in a similar way

(2) Alterations and Repairs: In such cases, permits are required before the work can be done. These are handled as prescribed by the ordinance—investigation of conditions being made by the inspector, drawings submitted, examined, corrections made if necessary and the permit issued or refused.

(3) New Installations: These are handled as prescribed by the ordinance, plans being required to be submitted. Recently we have secured the cooperation of the Bureau of Building Inspection. When an application for permit for a building is received by that Bureau, it must be approved so far as the fuel-burning apparatus is concerned by the Bureau of Smoke Regulation before building permit is issued.

The personnel of the Bureau is a Bureau Chief, four inspectors and two stenographer-clerks. At the present time, one inspector spends all of his time on direct observations of stacks; one spends all of his time on the inspection of locomotives, steamboats, steam shovels and portable hoists; one spends part of his time investigating complaints and the remaining part on direct observations. The fourth is on special work which consists largely of examinations of conditions where alterations or repairs are necessary and where new equipment is to be installed.

I have sketched very briefly a few points in the smoke problem. Summed up, it means where there is a smoke nuisance, it represents a direct economic loss. It is also a loss by reason of the poorer health, poorer living conditions and poorer spirits of the inhabitants; and such a place is less beautiful and less desirable for a home than it would otherwise be.

Can the smoke nuisance be eliminated? Yes. Easily? No. It means a constant fight, but the results are well worth all the effort ever put into it.

The foregoing paper by Mr. Meller was presented at the annual meeting of the League of Cities of the Third Class in Pennsylvania, held at York, Pa., on Aug. 25, 1920.

SOME MUNICIPAL IMPROVEMENT POLICIES OF ALBANY, NEW YORK

By Frank R. Lanagan, City Engineer, City Hall, Albany, N. Y.

Certain policies of the Bureau of Engineering of Albany, N. Y., effective in the last few years, had a good influence in guiding the many public improvements along proper channels.

Every Pavement Must Have Concrete Foundation

One policy which created friction at first but now cheerfully submitted to is that no street will be paved, even though the entire cost is paid for through assessment on the property benefited, except it has a concrete foundation. Under modern traffic conditions in a city, it is not economical to put down macadam, or asphalt—or tar-bound macadam, even though the street is a residential one, ordinarily subject to light traffic. There is nothing to prevent a five, eight or ten-ton coal or stone motor truck, or a heavy motor bus or ice wagon, or a team drawing heavy girders, from using such a street. One unduly heavily loaded vehicle in a single passage in the spring when the frost is coming out of the ground can and does do material damage to the carriageway by ruts or breaking through the surfacing and the annual cost for maintenance and repairs due to even this occasional heavy traffic makes this type of roadway on a city street more expensive than more permanent construction, higher in initial cost. Real estate speculators developing new streets as a general rule prefer and urge the cheapest kind of improvements because their greatest concern is to sell the lots, but it is better to stand adamant to their pleadings than to stand the reproaches of many property owners in three or five years time when one of the cheap improvements goes to pieces. Normally a city is a growing proposition and values are great enough to warrant more permanent improvements.

Effect of Public Improvements on Private Property

As a general rule, it is safe to assert that street improvements of a permanent character increase the value of real estate by more than the cost of the improvement assessed against the property in question. Improvements have been authorized on certain streets in poor localities where it has seemed as though the property could ill-afford to stand the assessment and yet after the completion of many of these improvements, owners have painted their houses, repaired their steps and stoops and spruced up generally. Windows which have not been so blessed for years get washed inside and out and clean curtains appear as by magic. Thus, more often than not, the tidiness of the roadway and walks is contagious. The whole improved condition of the street and bouses, favorably affects property values of the neighborhood. In business districts where obsolete pavements have been replaced with new wires placed in underground conduits, poles

and sidewalk encroachments removed and uniform sidewalks of concrete laid, extensive alterations and betterments to places of business have followed as a matter of course and in many cases, it has paid owners to construct new buildings because the generally improved condition has attracted trade.

Tree Planting

Another policy which has won some initial commendation and will merit more in the future, is the policy of planting trees on new residential streets in connection with the work of grading, paving, curbing and laying walks. There are a certain few varieties of shade trees that do well in the climate and soil of Albany and the choice of variety is restricted to these few. When the planting is done in connection with the improvement of the street, the work is done in co-operation of the Bureau of Parks with the Bureau of Engineering. The actual cost of the trees and planting is assessed against the property in connection with the other costs of the improvement to be assessed. As a general thing, one variety only is planted on a street. On some wide streets where there are grass plots in the center of the roadway, a different variety is planted in the center from what is planted on the walks. Sometimes, when conditions warrant, flowering shrubs of various kinds are planted in the grass plots. Where trees are planted near enough to the curbs to be within reach of horses, wire guards are used. With the growing use of motor vehicles in the city, there is not now the same need for wire guards as formerly but even so they continue to be of use if only to protect the bark from the small boy with a new jack-knife.

Controlling Street Layouts on Private Real Estate Developments

The policy of assuming control over new street layouts on private real estate developments became and is necessary to protect the city from inferior layouts, layouts which violate well-known principles of city planning.

In the year before the war when real estate was booming, so many developments were being put on the market with inferior street layouts that the city administration had to take action to protect the city and uninformed purchasers of lots. It is now necessary to have all plans for new streets approved by the City Engineer before a plan for a new development will be received by the County Clerk for filing. Approval by the City Engineer is also a guarantee of the future acceptance of deeds of the streets by the city for public streets. The city does not undertake to provide public facilities and conveniences such as sewers, water, sidewalks, curbs, pavements, lighting, etc., on private streets.

The approval of new street layouts in private developments is a difficult duty because a street layout that will cut a piece of property into the greatest number of lots and to the advantage of the owner may be just the layout which is unsuitable for the land, necessitating big cuts and fills in future grading, difficult to drain and connect into the sewerage system of the city. If the owner is made to change his plans to better meet these and other conditions and loses three, four or five lots from his plan in consequence, then he feels he has been badly treated by an unpracticable, visionary and unreasonable person.

The main difficulty with the present method of laying out new streets is that they are planned piece-meal, that is they are planned within the limits of a farm or single piece of property, without reference or thought as to how these streets will connect with future developments of adjacent properties or co-ordinate with the established system of city streets.

VIEWS TAKEN BEFORE AND AFTER REMOVAL OF SIDEWALK ENCROACHMENTS IN ALBANY, N. Y.

The proper way to plan new streets in undeveloped sections of the city is to consider the section as a whole, disregarding property lines of vacant land, making the street lines conform, so far as practicable and consistent with good planning, to the topography, varying the street widths to accommodate probable future traffic and connecting the new system in a proper manner to the established street plan of the city. The difficulty in making such a street plan effective as development takes place is the attitude of individual owners or real estate speculators who object to following a plan which does not cut their property to their best advantage. It is generally possible to convince such owners that values will be greater per lot with a good and proper street plan than with one which disregards adjacent properties and the established street system of the city. Publicity and public education by means of illustrated newspaper articles and by lantern slide lectures before improvement associations or similar societies will generally marshal public opinion in favor of the official plan and thus have a tendency to prevent a selfish interest from desiring to perpetuate an unwise development on the city.

THE LARGEST ASPHALT REFINERY IN THE WORLD

Pittsburgh and steel, Akron and rubber, Bridgeport and brass, East Liverpool and pottery, Texas and petroleum. Each pair is a mental link in one's chain of thought when either the locality or the industry is mentioned. It is singular to note, however, that every one of the industries mentioned has lent fame to a city, with the exception of the petroleum industry, and the entire State of Texas is associated inextricably with petroleum instead of a single city or town.

The town of Beaumont in Texas gained extensive prominence when the famous Spindle Top field was discovered, and the town of Burkburnett has become noted through the petroleum fields there. Neither of these two places, however, is so widely known as to be called the Pittsburgh of the petroleum industry. Yet there are petroleum refineries in Texas which are the largest of their kind in the world and any one of them would make a city famous. These plants are spread over a large area, however, and therefore no one place gets the advantage of the prominence which would sprout from their concentration.

So enormously has the petroleum industry grown in Texas that there are stupendous plants there devoted exclusively to the manufacture of single petroleum products. An example of this is the largest asphalt refinery in the world operated by The Texas Company at Port Neches, Texas. It extends ¾ of a mile along the Neches River and 2½ miles back into the country, and has become world-famed among persons interested in road building and other uses of asphalt. Were this plant in another locality, say as central as Pittsburgh or Akron, it would bring fame to the city or town near which it was situated. As it is, however, the town of Port Neches and the mammoth asphalt refinery there are noted mostly among the world-wide users of asphalt products, and are not famous generally among laymen of all descriptions as Pittsburgh and its steel mills are.

Fame is Growing

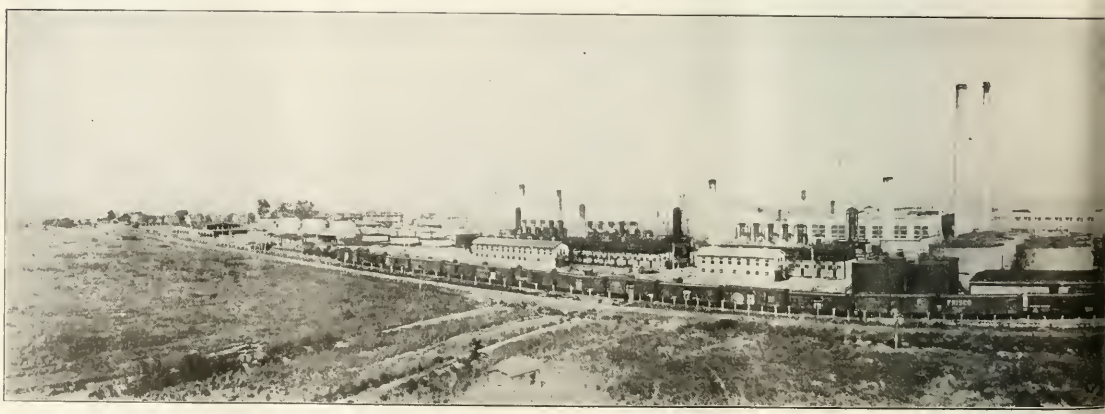
Destiny, however, seems bent on spreading a broader mantle of prominence over this largest of the world's asphalt refineries. It is coming about in this way. The people in every state in the country are realizing the vital demand being made through the growth of the automobile and motor truck industry. This greatest demand is

SCENE IN ASPHALT LABORATORY AT THE PORT NECHES REFINERY OF THE TEXAS COMPANY SHOWING, IN FOREGROUND, MACHINE TO MEASURE DUCTILITY OF ASPHALT.

for *Good Roads*, as the 7,143,954 automobiles and 421,692 motor trucks that are being operated in this country must have improved highways to ride over. It is an economic necessity!

So, in view of these facts, the layman as well as the engineer and the road builder is taking an interest in improved highways. He wants to know how the money is spent on the new highways, how the roads are built, what materials are used and where they come from; hence, wide public attention to the Port Neches asphalt refinery is increasing steadily.

As one enters the asphalt refinery he immediately is impressed by two things: first, the immensity of the place, and second, the quietness of it. His vision is overtaxed by the mammoth size of the plant, and his curiosity is aroused because there seems to be so little noise. Sure-



Executive Offices Storage Tanks Storage Tanks Stills

BIRD'S-EYE VIEW OF THE PORT NECHES REFINERY OF THE TEXAS COMPANY, LOCATED AT

ly there are not hundreds of persons employed here! One sees only a few men briskly walking about performing their duties! Yet, in reality, there are scores and

EXPERT OPERATOR OF THE TEXAS COMPANY DETERMINING THE FLASH POINT OF A SAMPLE OF ASPHALT IN LABORATORY OF THE PORT NECHES REFINERY.

scores of men working with trained eye, mind and hand in turning out the asphalt products which will later form a large part of the country's lasting highways.

In the first glance over the refinery one sees the company's large docks and waterfront;—in back of these is the civic center, where are located the offices, dormitories, commissary, club house, and cottages for the employes. Next the eye will note immense storage tanks, then lengthy rows of stills, storage sheds, locomotives, and railroad tracks, and numerous other buildings and structures. A description of the entire refinery, however, may be given by following the asphalt through the process of production.

Process of Production

The crude asphaltic base petroleum from the oil fields is transported to the refinery through pipe lines and in large tank ships; upon arrival at the refinery it is pumped into storage tanks. From the storage tanks the material is pumped into the stills, of which there are 70 at the Port Neches plant. These stills are dull and insignificant in appearance despite the all-important part they perform in the production of the asphalt;—they don't even look as if they were hot. They look like enormous boilers set in brick and are strikingly similar to the average steam boiler, only much larger. The brick walls cover two-thirds of the stills, which look from the front like ordinary furnaces with doors and pipes, gauges and other devices. As oil is used for fuel, there is little to be seen other than the oil pipes which spit forth their fluid into the white-hot fires.

About all one can see of the process of making asphalt is the gauges which denote the maintenance of temperature at certain specified degrees, the addition of crude material from time to time and the removal of the finished product from the stills. The stills are in two rows with the furnace ends facing a street about 100 ft. wide. This passage way is as clean and devoid of excitement as the average walk on a country estate. Now and then a man in overalls comes to the scene, passes along the front of the stills looking at the gauges, turns something somewhere and passes on leaving the street as deserted as it was before he made his visit.

As a producer of excitement the production of asphalt is a dismal failure. It is the most unexciting thing in the world considering the tremendous importance of the process. Workmen move about with deliberation and calmness and give a distinct impression that they know what they are doing and why they are doing it, but the uninitiated would never guess their thoughts!

When the crude asphaltic base petroleum is pumped into the stills it is maintained at specific temperatures for certain lengths of time. The lighter oils are removed during the process of distillation and are pumped to another refinery, leaving the thick, binding, adhesive asphaltic base. This process is continued until the asphalt reaches the proper consistency. From the stills the finished asphalt is pumped while hot into large storage tanks or directly into barrels or tank cars.

Testing the Asphalt During Refining

Food that passes over the tables of American homes is not examined and tested and fussed over one-tenth as

Box Cards Loaded with Asphalt in Barrels Barrels of Asphalt on Flat Cars Storage Sheds and Tank Fields
PORT NECHES, TEXAS. THIS IS THE LARGEST ASPHALT REFINERY IN THE WORLD.

much as the asphalt is during the process of refining. Pharmacists in mixing prescriptions are no more exacting and minute in their work than the chemists who test the asphalt which will later be mixed with other materials for the country's highways.

Each batch of asphalt goes through 50 different tests before it is turned out as a finished product. In the complete and modern laboratory of the refinery, a group of chemists perform these tests, each one making his test independently and then comparing the results with those of his associates.

Tests are made for penetration, ductility, flash point, solubility, specific gravity, etc. The penetration test records the hardness of the material, the ductility test shows its stretching power or cohesion, the flash point denotes at what temperature the product will catch fire, the solu-

ROW OF HOUSES BUILT FOR AND OCCUPIED BY EMPLOYEES AT THE PORT NECHES ASPHALT REFINERY OF THE TEXAS COMPANY AT PORT NECHES, TEXAS.

bility test indicates the purity of the product and its freedom from foreign substances, and the specific gravity test indicates the weight of the asphalt as compared with that of water.

Perhaps the most interesting test is that made for ductility. A block of asphalt is placed in a trough of water maintained at a certain temperature. A motor is then started and stretches the asphalt until it breaks, the breaking point measured in length, usually centimeters, being the required information.

More than a score of standard grades of asphalt, road oils and binders are produced at the Port Neches plant of The Texas Company. This illustrates the care and precision necessary in the chemical and physical tests, as the various products range from the light road oils and binders to the harder materials for heavy highway traffic, and for the production of roofing, paints, and other commercial commodities.

The remainder of the refinery consists of storage sheds, a thoroughly modern plant where all the barrels and drums are made, machinery shops and maintenance depots. The storage sheds have a capacity of more than 500,000 barrels of asphalt, while the cooperage plant is one of the most complete in the country, and in itself comprises a large industry.

The transportation system of the refinery is equally complete. There are 15 miles of standard gauge railway inside and five locomotives are kept busy constantly moving the large shipments.

Housing and Social Life

Cottages, dormitories, a field for athletics, a club house and ball room, combined with many other conveniences, provide an enviable home and social life for the employes. Only a nominal charge is made for board and lodging, and the management prides itself on its efforts and success in providing amusement and pleasure for the refinery's employes.

TRANSPORTATION OF GARBAGE WITH DATA ON GARBAGE DISPOSAL IN VARIOUS CITIES

By Samuel A. Greeley, of Pearse, Greeley & Hansen, Hydraulic and Sanitary Engineers, 39 W. Adams St., Chicago, Ill.

(Editor's Note:—Mr. Greeley recently made a report to Mr. David H. Goodwillie, Director of Public Service. Toledo, Ohio, recording the results of the investigation of garbage collection and disposal in Toledo, the canvass of bids received, the investigation of various processes for garbage disposal proposed and used in other cities, together with the result of studies made of the data so secured. An award was made in July, 1920, to the Toledo Disposal Co. for disposal by reduction. Mr. Greeley's report contains much information of general interest, in addition to that pertaining directly to Toledo conditions, and from this general information the following data and discussions are here presented for the information of other engineers and officials.)

TABLE I—COST OF TRANSPORTING GARBAGE

City	Year	Method	Tons of garbage	Cost of trans. per ton
Chicago	1919	Barge	786	0.962
Baltimore	1920	Barge		.30
Detroit	1920	Railroad		.75
Washington, D. C.	1919	Railroad	53,258	.68
Cleveland	1918	Railroad	57,754	0.342
Pittsburgh, Pa.	1920	Railroad	60,000	.60
Columbus	1918	Railroad	15,630	0.203
Indianapolis	1919	Railroad	16,587	.26
Dayton	1919	Railroad	11,360	.55
Grand Rapids	1917	Railroad	10,500	0.45
Utica, N. Y.	1919	Tractor-Trucks	8,400	1.43
Wilkesbarre	1918	Truck	7,500	1.60

Transportation of Garbage

In most cities the garbage is delivered in the collection wagons by team haul to the place of disposal. In some of the larger cities, where the haul is long, it becomes economical to provide transportation in larger quantities than the collection wagons. There is then required one or more loading stations and vehicles for the transportation. The methods of transportation in general use at present are the following: Steam railroad, boat, truck, tractor-trailer and electric railroad.

a. *Loading Stations* are required to unload the collection wagons and to load the transportation vehicles. They

TABLE II—COLLECTION DATA FOR SEVERAL CITIES

City	Number of houses per collection per working day	Time in minutes per house—one man basis
Pittsburgh	275	
Washington	480	0.91
New Orleans	456	
Chicago		1.47
West New Brighton		0.91
Evanston	79	1.21
Lake Forest		10.00
Louisville		0.37
Milwaukee	89	2.32

TABLE III—APPROXIMATE NUMBER OF WAGONS FOR GARBAGE COLLECTION

City	Approximate population from which collections are made	Wagons: Number	Wagons: Capacity cu. yds.	Approximate interval between collection days	No. of trips per wagon per day	No. of men per wagon	Average No. of wagons per 100,000 population
1. Chicago	2,000,000		4.0	6	1	1	
2. Cleveland	790,000	105	2.5			1-2	13.3
3. Baltimore	700,000	200	2.5	2			28.6
4. Los Angeles	575,000	49	5.0	1-3	2.3	1	8.5
5. Buffalo	500,000	18	5.0	2	2	3	3.6
6. Milwaukee	450,000	100	1.5	6	2	1	22.2
7. Pittsburgh	450,000	50	4.75	6	2	2	11.1
8. Washington	430,000	90	2.2	2-3		1-2	20.9
9. Newark	300,000	14	4.0	2	3	2-3	4.7
10. Columbus	230,000	22	3.0	6	1	1	9.6
11. Worcester	120,000	19	2.5	3	1	1	15.8
12. Toledo							
Actual	240,000	28	3.0	6	1	1-2	11.7
Proposed		22	3.0-4.25	6	1-2	1-2	9.2

are of several different types. Some comprise an elevated platform, with inclined approaches, from which the wagons are dumped into freight cars, boats or other vehicles. The platform should preferably be attractively housed, be built with concrete floors and fitted with ample water supply and sewerage for washing. Other loading stations comprise a crane for picking up wagon bodies and emptying them into or placing them on the transportation vehicle. Loading stations are in operation at the following, among the 50 larger cities in the United States: New York, Chicago, Philadelphia, Detroit, Baltimore, St. Louis, Pittsburgh, Cleveland, Boston, Cincinnati, Minneapolis, New Orleans, Columbus, Grand Rapids, Dayton, Washington and Salt Lake City.

Many of the loading stations are quite critically located; some are well built and others rather poorly. New York, Chicago, Baltimore and Boston have water front loading stations and boat transportation. All of the others have railroad service. In Philadelphia, Detroit, Boston and Columbus, the loading stations are housed, but in many of the others the platforms are uncovered. Most of these loading stations have been in operation many years. Nevertheless, because they should be near built-up districts where the garbage is produced, it is always difficult to secure locations.

b. *Steam Railroad Transportation* is the most usual method. Amongst the 50 large cities, it is used by the following: Detroit, St. Louis, Pittsburgh, Cleveland, Cincinnati, Minneapolis, New Orleans, Columbus, Grand Rapids, Dayton, Salt Lake City and Washington.

Various kinds of cars are used. Cleveland and Columbus have specially built side dumping cars. Detroit and Minneapolis have flat cars on which the wagon bodies are stacked. In Pittsburgh the cars have high sides, re-

TABLE IV—APPROXIMATE DATA ON GARBAGE DISPOSAL BY FEEDING TO HOGS

City	Population 1920	Ave. tons garbage per day	Place of delivery to contractors	Method of haul to farm	Distance from farm to city limits—miles	Area of farm—acres	Average No. of hogs	Payment to city per ton
Baltimore	733,826		Farm	Boat	12	160	4,000	$0.52
St. Louis	733,000		Farm		15			0.25
Buffalo	505,875	60	Farm	Tractors	4	69		.50-.90
Newark	415,609	30	Farm	Team	0	8	4,500	1.20
Minneapolis	380,498		Tr. Sta.	Railroad	6	80	2,000	1.26
Portland	(308,319)		Tr. Sta.	Team	1			3.90
Denver	256,369	60	Houses	Team	½		10,000	
St. Paul	234,595			Team				1.95
Louisville	234,891		Tr. Sta.					3.50
Akron	208,435	47	Farm	Team-Trucks		200		1.00
Providence	(259,895)	100	Houses		7	1,000		
Worcester	(166,106)	30	Houses	Team	0	376	3,000	
Grand Rapids	137,634	36	Tr. Sta.	Railroad	43	240	6,000	0.25
Omaha	191,601	50	Farm	Team	0		5,000	.06
Salt Lake City	118,110	15	Tr. Sta.	Railroad	6	60	2,000	
Utica	94,136	25	Farm	Tractors	4	160	1,600	
Wilkesbarre	73,828							
Topeka	(49,538)	10	Houses	Team-Trucks	1	15	800	0.0
Madison	38,378	10	Farm	Team-Trucks	3			
Highland Park	46,599	15	Tr. Sta.	Team	4	40	600	0.45

Notes—1. Other cities feeding: Kansas City, Wheeling, Hartford, Cambridge, Kalamazoo, Jackson, Rockford, Harrisburg.

TABLE V—APPROXIMATE DATA ON HOG FARMS FOR GARBAGE DISPOSAL

City	Approx. population 1920	Tons of garbage per day May, 1920	Number of hogs 1920: Capacity	Number of hogs 1920: Total	Number of hogs 1920: Per ton garbage	Area of farm in acres	Amount of hog manure: Total No. of men	Amount of hog manure: % garbage	Sq. ft. per hog: Pen	Sq. ft. per hog: Feeding platform
Baltimore	700,000	33	5,000	850	26	157	8-14	50	7.6	4.8
Newark	415,000	38	4,000	1,210	32	8	5	50	7.5	2.4
Buffalo	600,000	60	5,000	4,300	71	69	12	30	7.5	17.0
Highland Park	40,000	14	750	750	53	40		50 to 57		
Worcester	175,000	30	3,000	3,000	100	376	10	65	7.2	
Minneapolis	380,000	50	2,500	2,500	50					

TABLE VI—METHOD OF GARBAGE DISPOSAL IN THE 50 LARGEST CITIES OF THE UNITED STATES

As taken from Table 6—Bulletin 133, U. S. Census, 1916

Dumping	Incineration	Reduction	Hog feeding	Changed from reduction to hog feeding	Changed from hog feeding to reduction
New York	Milwaukee	Chicago	Buffalo	Buffalo	Los Angeles
New Orleans	Atlanta	Boston	Newark	Baltimore	
Seattle	Scranton	Pittsburgh	Baltimore	Akron	
San Francisco	Minneapolis	Detroit	Denver	St. Louis	
Oakland	Birmingham	Cincinnati	Worcester		
Jersey City	Richmond	Cleveland	St. Paul		
Dallas	Spokane	Columbus	Louisville		
	Memphis	Dayton	Portland		
	Paterson	Indianapolis	Akron		
	San Antonio	Los Angeles	Salt Lake City		
		Rochester	Providence		
		Toledo	Grand Rapids		
		Syracuse	Omaha		
		Philadelphia	St. Louis		
		Washington	New Haven		
		Bridgeport	Fall River		
		New Bedford			

sembling box cars with the roof off. Most of the others use gondola type freight cars.

c. *Boat Transportation* is used in New York, Chicago, Boston and Baltimore. In Chicago only a small amount of the garbage is transported on deck scows, the wagon bodies being stacked two deep. In the other three cities the garbage is dumped in bulk into barges.

d. *Truck or Tractor-Trailer Transportation* is a more recent development, being used in the following of the 50 larger cities: Trucks—Akron, Atlanta and Wilkesbarre; Tractor-Trailers—Buffalo, Indianapolis and Utica.

This method requires a high first cost with a correspondingly high interest and depreciation cost.

e. *Team Haul.* In by far the largest number of cities the garbage is delivered to the disposal plant direct by team haul as follows: Chicago, Los Angeles, Portland, Milwaukee, San Francisco, Toledo, Louisville, St. Paul, Providence, Denver, Seattle, Rochester, Jersey City, Oakland, Kansas City, Bridgeport, Birmingham, Scranton, New Haven, Worcester, Syracuse, Schenectady, San Antonio, Richmond, Omaha, Fall River, New Bedford, Paterson, Memphis and Spokane.

This general summary provides a perspective of practice in this country. In Chicago, Brooklyn and Philadelphia some mixed refuse has been transported by trolley cars. In Chicago this method has been abandoned because no dump accessible to trolley tracks is available.

In all cases cleanliness is an essential to successful operation, particularly as regards loading stations.

The accompanying tabular matter is of wide interest. Table I gives the method and cost of transporting a ton of garbage in various American cities. In Table II is given the average time in minutes required to collect the garbage from a house in 9 cities. Table III gives the approximate number of wagons for garbage collection used in 12 cities. Table IV gives a quantity of approximate data on garbage disposed by feeding to hogs in 20 cities, and Table V gives approximate data on the hog farms used for garbage disposal in 6 cities. Table VI gives the method of garbage disposal in the 50 largest cities of the United States.

SURFACE TREATMENT OF STONE AND GRAVEL MACADAM AND CONCRETE ROADS IN WISCONSIN

By J. T. Donaghey, Maintenance Engineer, Wisconsin Highway Commission, Madison, Wis.

(Editor's Note: The following instructions on the surface treatment of stone and gravel macadam and concrete roads in Wisconsin were recently issued for the guidance of patrolmen, in Bulletin No. 11 of the Wisconsin Highway Commission.)

Sweeping the Surface

Sweep the surface of the road with a power sweeper until all dust is entirely removed from the stone surface, and remove the accumulations of dirt and vegetable matter from along the edges of the stone surface with the light grader.

If there are any spots of vegetable matter remaining on the surface, remove them by the use of a hand broom or shovel.

Be sure to have the surface clean before starting your oiler for if there are any spots not thoroughly cleaned, the oil will not penetrate to the road metal, leaving a blanket of dirt between the oil and the stone which will eventually pit out, causing very disagreeable holes in the road surface.

Where a surface treated road has become wavy or uneven it is best to scarify it rather than to attempt to even it up in any other way. The scarifying should be done as early in the season as possible while the ground and stone underneath the surface is cold. At this time the old surface treatment will break up and can be harrowed with much less effort than later in the season when the weather and material are warm. After scarifying, the surface should be thoroughly harrowed with a heavy peg-tooth harrow gone over with the blade grader a sufficient number of times to remove all waves and depressions that were formerly in the surface. The surface should now be gone over a few times with a road roller in order to compact the loosened material after which the surface treatment should be applied in the usual manner and an absorbent of torpedo sand or pea gravel or stone chips applied.

It is advisable at times to use stone as large as 1½ ins. in size, rolling the stone into the surface of the road after the bitumen has been applied. The larger stone practically nails down the surface to the old metal and keeps waves from forming in the future.

Distributor

Use a pressure distributor and have power enough before it to move along at a speed that will develop the necessary pressure to insure an even distribution of the oil. A motor truck supplies the best power for the majority of distributors, but good results may be obtained with four horses. A few counties have purchased motor oilers which are very satisfactory. Others have mounted a tank and distributor on a motor truck resulting in equally good work.

Bitumen

Use a bitumen that can be applied easily without heating. It is much more convenient, less expensive, and gives equally good results. The amount required will vary with the condition of the surface. A new road will require a full half gallon to the square yard, and possibly more, while a road that has been previously treated will require less than that amount. There are more failures from using not enough bitumen than from using too much.

It is best to apply ¼ gal. of bitumen at the first application, allowing 24 hours for penetration before the second application.

Following the second application of bitumen for the first surface treatment, an absorbent covering of sharp, clean torpedo sand or stone chips not to exceed ½ in. in size should be applied. This will absorb all excess bitumen, fill the holes in the road surface, and form a carpet which will protect the stone surface from wear and displacement.

The best method of applying the sand or stone chips is to deposit them in small piles along the shoulders of the road and apply by hand with a square pointed shovel as required. In many instances it is impractical to deposit the absorbent along the roadside. In this event the material is spread by hand from a motor truck or wagon. One cubic yard will cover properly about 120 sq. yds. of surface.

"Tarvia-KP" sand and stone are turned over by hand until all stones are coated
The hole to be patched is cleaned out and the bottom and the sides are painted with "Tarvia-KP"
The mixture is shoveled into the hole and is well tamped
Workingman in foreground is scattering screenings over seal-coat. Then patch is again tamped

Tarvia-KP

FOR COLD PATCHING

Road repairs *now* save money next spring—

If your roads are scarred from summer traffic, prompt patching with "Tarvia-KP" will save expensive repair work in the spring of next year.

The fall and early winter is the logical time to make economical repairs that will put your roads in prime condition during the winter.

"Tarvia-KP" used now, and whenever your roads are free from snow, will make small patches answer where large ones would be required next spring. And the time you save can well be used next spring in the work of road surfacing and new construction.

"Tarvia-KP" is unequaled as a quick, dependable, ever-available patching material for every type of road. It requires no heating, is extremely easy to handle and will stand up under the heaviest traffic. Freezing does not injure it.

Address our nearest office, outlining your road problems and get the free advice of our trained specialists.

The Barrett Company

New York Chicago Philadelphia Boston St. Louis Cleveland Cincinnati Pittsburgh
Detroit New Orleans Birmingham Kansas City Minneapolis Nashville Syracuse Salt Lake City
Seattle Peoria Atlanta Duluth Milwaukee Bangor Washington Johnstown Lebanon Youngstown
Toledo Columbus Richmond Latrobe Dallas Bethlehem Elizabeth Buffalo Baltimore

THE BARRETT COMPANY, Limited: Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax N. S. Sydney, N. S.

Keep travel off the surface for at least 48 hours after the absorbent is applied.

Each succeeding surface treatment will require a little less bitumen and an increase in the size of stone chips used, until in the fourth or fifth year stone from 1 in. to 1½ ins. in size may be used.

As the material used is increased in size, it should be well rolled into the surface and will soon form a new wearing surface. It is very important that surface treatment be applied early in the season. The months of May and June are the proper time.

Counties requiring the use of several cars of bitumen annually are constructing one or more concrete oil storage tanks. The cost of a 36,000 gal. tank is approximately $1,000. Plans for construction of these tanks will be furnished by the commission upon application.

Where this method of surface treatment is followed, a macadam road should have a better wearing surface at the end of almost any period of years than when first built, except under extremely heavy traffic conditions.

(One of the 36,000 gal. oil storage tanks was built at Portage, Columbia County. This is a reinforced concrete tank 20 ft. in diameter and 20 ft. in length, with a concrete roof. The tank was built in 1918, under the supervision of J. T. Henton, County Highway Commissioner, at a cost of about $1,000.)

Bituminous Macadam

Bituminous macadam requires practically the same method of surface treatment as is described under surface treatment of water-bound macadam, the only difference being that bituminous macadam surface does not need surface treatment as early in its life or as frequently as a water-bound macadam. However, it should be surface treated once every two or three years and if good bituminous material and clean hard stone chips are used, the surface treatment will build up the wearing surface and the road should remain as good if not better than when originally built.

Concrete Roads

It is economy to have a small maintenance crew go over all the concrete roads in the county twice each year. Such a crew consists of a foreman, one team or motor truck hauling the material, and four laborers, equipped with a tar heating kettle. This crew covers under average conditions all the joints, cracks, and small pits in from one to two miles of 16 or 18 ft. road in one day, at a cost of from $25 to $75 per mile for labor and materials. The tools used consist of a wheelbarrow, two fibre street brooms, two wire brooms, a couple of shovels, and a pouring pot having a round spout.

Cracks and Joints

Two men are utilized to sweep all cracks clean with the wire brooms, after which a man with a pouring pot fills the cracks with a special Tarvia "X" which is heated to about 225 deg. Fahrenheit. It is then allowed to stand in the crack for a few minutes to prevent "bubbling" out in case the sand is wet. The sand, which should be dry and coarse, is spread with a shovel over the crack and into the tar, and the whole is left for traffic to iron out.

On many of the older concrete surfacings, especially those where armour plate was used to protect the joints, we find that many joints are appreciably higher than the balance of the pavement. This disagreeable feature is emphasized in many instances by the improper application of the tar in filling the joints. An excessive amount of tar is often poured which runs over the edges of the opening and results in a higher joint than before.

Milwaukee County had more of this trouble than any other county in the State, and they have recently devised a machine for removing the old excess tar and cutting down the joints, both the concrete and steel.

A small air compressor and pneumatic chisel are used, operated by a gasoline engine. This gives very satisfactory results and removes the disagreeable feature of a high joint.

Care must be taken not to over-fill the cracks and joints with the tar. If the tar is allowed to spread over 3 or 4 ins. of the edge of each slab it will protect the slab from wearing and there is soon a noticeable difference between the portion protected and the portion unprotected and after a few years wear this will in itself produce a high joint.

To fill cracks and joints properly, especially on grades, it is good practice to spread a light bank of sand along each side of the crack or joint which will prevent the bitumen from spreading. It will also insure the joints being entirely filled. After the bitumen has been allowed a reasonable length of time for penetration, the sand can be swept over the crack and if more sand is necessary it can then be applied.

This method of repair prevents the edges of the concrete from spalling and chipping, and no water can penetrate to the subgrade to freeze and heave the concrete. The work is done preferably in dry, hot weather, first as early in the season as the weather will permit and again near the close of the season.

Depressions and Holes

In case small depressions occur, the time to repair them is when they appear. The best method of repair is as follows:

The surface is first swept with a steel broom to loosen the dirt; after this, the spot is thoroughly swept with fibre street brooms. To remove the fine dust which the steel brooms leave behind, ordinary house brooms are used which leave the surface fairly clean.

The depression is then covered with hot Tarvia "X," then with coarse sand or screenings, and opened to traffic. In case the depression is of considerable depth, or what might be called a hole, one of two methods is advisable:

First (in case you want to avoid delaying traffic), clean the depression as already described and then paint it with tar, upon which bring the hole to grade with crushed stone, being careful not to have the stone as large in size as the depth of the depression. Tamp the stone in place with hand-tampers or roll with a roller, if one is available, and fill the voids with a heavy bituminous road binder, allowing about ¾ gal. per sq. yd. per in. in depth. Cover the surface with torpedo sand or stone chips.

The second method is to cut the poor place out entirely and after trimming the hole and thoroughly sprinkling the sides, fill with the same mixture as was used in the original road. After pouring the concrete, treat the same as in reconstruction.

Small defects due to balls of clay, sticks or coal getting into the aggregate may be best repaired as described for shallow depressions. The same is true of battered joints or cracks that may appear.

WATER WORKS SECTION

WELL TESTS—THE BASIS FOR PUMP SELECTION

By George M. Shepard, Assoc. Mem. Am. Soc. C. E., Associate with L. P. Wolff, Consulting Engineer, 1000 Guardian Life Bldg., St. Paul, Minn.

In municipal practice it is frequently found that pumping machinery is purchased and installed without reference to the special service which it is to perform or the conditions under which it is to operate. Before selecting the type of pump which is to raise water directly from a well it is important to know the yield for different elevations of water surface below ground level. If at all possible, tubular wells should be thoroughly tested before pumping machinery specifications are drawn up. A small expenditure for a complete test will more than amply repay itself in the additional economy of operation of a pump, the design of which is based upon complete information.

Considerations Affecting Choice of Pump

The type of pump to be specified will depend upon different conditions, such as yield, water level of well, continuous or intermittent operation of pump, character of service and population to be served. For shallow tubular wells or wells where the pump may be placed close to water level either on the surface or in a pit, direct motor driven centrifugal pumps with suction drop pipe and foot valve inside of the well casing are perhaps the most economical method of direct pumping for isolated units or small installations. Frequently a group of shallow tubular wells are connected to a single suction line and the supply pumped by a vertical motor driven centrifugal pump, the pump being placed in a pit below the normal water level. Such a pump may be driven by a vertical motor and shaft, the motor being placed in a small house at ground level above the pit. The supply is frequently taken from large open wells in the same manner with vertical motor and shaft driven centrifugal pumps.

Where the required supply can be obtained within the limits of suction, i. e., for practical purposes, 22 or 23 ft. and where a foot valve or proper priming facilities are provided a reciprocating power or steam pump may be used. The writer has observed a suction lift as high as 26 ft. under good conditions of pipe work.

Where the supply cannot be obtained within the suction limits of a pump set at ground surface or in a pit, either a deep well cylinder pump, an air lift or a vertical motor driven turbine centrifugal pump may be used. Where only one well is available and storage is not sufficient to tide over the period required for repairs necessary for a deep well cylinder pump or a turbine pump, the air lift has many advantages provided sufficient submergence can be obtained for satisfactory operation.

Very frequently pumps are specified upon the basis of existing wells in the vicinity. This method frequently gives rise to erroneous results especially in rock and gravel formation as crevices and veins in rock and pockets in gravel always affect the yield of a well.

Two Examples of Well Tests and Pump Selection

As an example of conditions developed by tests upon which different types of pumping machinery were specified are the two following cases.

Example No. 1 is the well at Hinckley, Minn., which

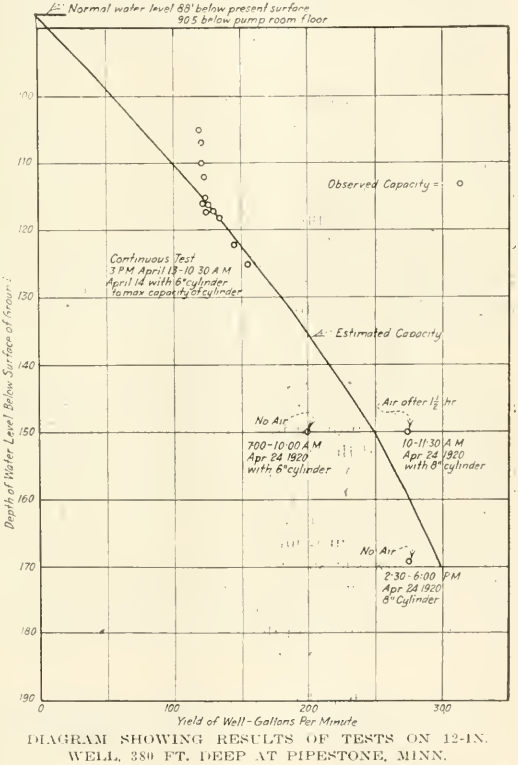


DIAGRAM SHOWING RESULTS OF TESTS ON 12-IN. WELL, 380 FT. DEEP AT PIPESTONE, MINN.

was drilled in 1919. This well is 10 ins. in diameter, 400 ft. deep and cased to rock at 23 ft. below the surface. The water stands normally in the casing at a distance of 14 ft. below the ground surface. The rock formation consisted of alternate layers of hard and soft sandstone, the soft layers being very reddish in color. Upon completion the well was tested with a 6 in. cylinder placed with the bottom of cylinder 35 ft. below the surface, and the speed of the piston was increased until air was drawn in at the bottom of the cylinder, the discharge of the pump being 190 gals. per minute at this point. By lowering the cylinder to 47 ft. the discharge was increased to 216 gals. per minute.

Printed as insert to Municipal and County Engineering, Chicago, Ill., October, 1920.

Centrifugal Pump Specified

Inasmuch as a 200 gal. supply, in connection with the storage tank, was sufficient for this village with a population of 800, it was determined to place a direct motor driven centrifugal pump in a pit at a depth of 11 ft. below ground surface or just above the level to which the water normally rose in the casing. A centrifugal pump for the required lift, including suction, was specified for the actual discharge, with a drop pipe 30 ft. long and foot valve inside of the casing. The final test of pump showed that about 220 gals. per minute were being discharged against normal head when full suction lift was developed. This gave an economical installation and one requiring little attention, which is an important item in a small city or village without a regular water works superintendent. The test was carried on in this case until the well cleared, requiring 71 hours and a cost of $248 for the test and pumping, the labor and equipment being furnished by the well driller.

Example No. 2 is a well at Pipestone, Minn. This well is a 12-in. well, 380 ft. deep, cased to rock at a depth of 9 ft. The rock consisted of a pink and reddish quartzite from a depth of 87 ft. to 177 ft. Between 177 and 220 ft. a crevice in very hard quartzite was encountered, requiring blasting. Between 220 and 380 ft. a softer material having the appearance of a dense sandrock was penetrated. Upon the completion of the well the water normally stood at elevation 88 ft. below the surface. The results of the tests of the well are shown in the accompanying diagram, the first test being made with a 6-in. cylinder, and the second with an 8-in. cylinder.

An Air Lift Specified

On account of the difficulty in obtaining water in this particular region for a city with a population of 3,000, it was necessary to provide for continuous pumping of both the new well and the old well located in a different portion of the city. A reservoir was provided near the station, so that the well may be pumped practically continuously. The test indicates that for a supply of 200 gals. per minute the pump would have to be placed at a depth of 140 ft. below the surface of the ground, which for a cylinder pump would require long pump rods. In this case an air lift was specified on account of the absence of reciprocating parts and the greater reliability of an air lift for continuous service if installed with proper submergence.

It is believed that these two examples give extremes which may be met with in ordinary practice and illustrate the necessity of well tests as a basis for preparation of pump specifications.

MUNICIPAL WATER WORKS CONSTRUCTION AT POST-WAR PRICES.

By Maurice R. Scharff, Asst. Chief Engineer, Morris Knowles, Inc., Engineers, Pittsburgh, Penna.

Some of the most trying problems of managers of municipal water works, these days when prices are constantly changing (in general to higher levels), arise out of the necessity of carrying out urgently needed construction under price conditions widely different from those at the time when the plans and financial provisions for the work were made. The managers of municipally owned plants are faced by even greater difficulties in this respect than those of company owned plants, owing to the restrictions with which municipal bond issues and construction contracts are hedged about.

Postponements Not Always Possible

In most cases, the difficulties have been so great that the postponement of the work, in the hope of better days to come, has seemed the only way out. In some cases, however, the demands of public service have been so urgent as to make postponement a source either of serious danger, or of the restriction of growth of a healthy community. Numerous examples can be found where the officials concerned have courageously faced the situation, and where, with water works material and labor costs advanced 100 to 200 per cent, and under financial conditions prohibiting the securing of additional funds, they have schemed and planned, and cut and rearranged, so as to supply in devotion and ingenuity what they lacked in money, and to secure for the public as great a proportion of the improvement of service planned as was possible with the funds provided.

Expedients Adoped at Elyria, Ohio

An example of this kind is offered by the new water works now being constructed under the direction of Mayor A. R. Jones and Service Director H. A. Beck for the City of Elyria, Ohio. An account of the expedients that have had to be adopted in connection with this work it may be of interest to other municipal officials who are faced by a similar urgent need of improvements planned some time ago, and postponed until the present time.

In 1918, the City of Elyria had a report prepared on the requirements of its water works system, and a new filter plant and pump station, and an additional force main, were recommended, at an estimated cost of about $750,000. Shortly afterward, a bond issue of $1,000,000 was authorized by vote of the citizens. Under the unsettled conditions existing at the time, it is natural that there should have been some hesitation about proceeding with the work. But the age and condition of the existing plant and force main made indefinite postponement dangerous. In the summer of 1919, therefore, Morris Knowles Inc. were engaged as engineers and authorized to proceed with the preparation of plans and specifications for the work.

New Plant as Originally Planned

Plans were prepared upon the basis of a filter capacity of 12,000,000 gals. per day, with provision for ultimate extension of 48,000,000 gals. per day. The improvement included a pumping station with three turbine driven centrifugal low lift pumping units of 6 million gallons per day each, and a high duty horizontal crank and fly wheel pumping engine of 8 million gallons per day capacity, which with the existing high service pumps installed in the new station, would give a total high lift pumping capacity of 16 million gallons per day. Plans also provided for a 36 in. cast iron, wood, or steel force main, paralleling an existing 20 in. cast iron main, 23,800 ft. long from the site of the plant at Lake Erie to approximately the city limits of Elyria. A general plan of the plant as originally designed is shown herewith.

Pipe and Pump Contracts

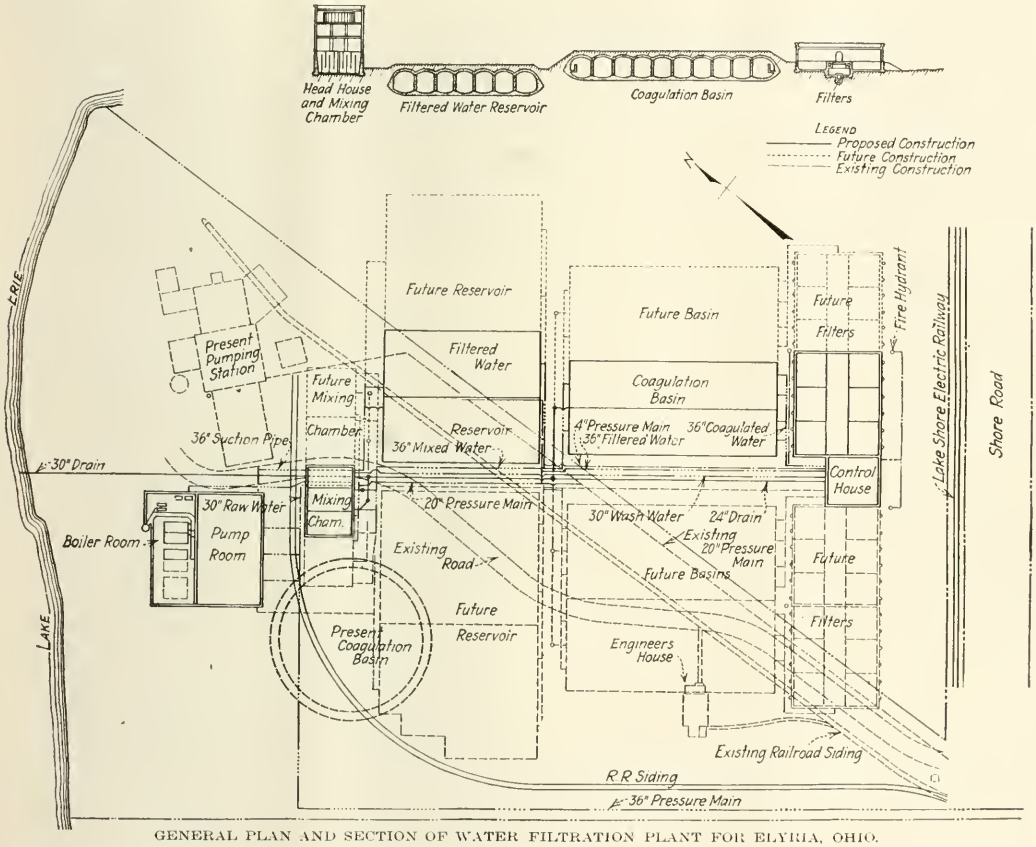
The first work on which bids were taken was the pipe (materials only) and the pumping engines, contracts for which were let in January, 1920, as follows:

Steel Pipe—
854 tons at $108 per ton.....$92,232
516 tons at $115 per ton..... 59,340
Valves 6,165
Low lift pumps—turbine driven centrifugals, capacity 6 million gallons per day against 60 ft. head—each 5,850
High lift pump—horizontal crank, fly wheel unit, capacity 8 million gallons per day against 345 ft. head 50,500

Prices were continuing to advance, however, and by the time plans were ready for securing bids on pipe laying again and advertise a third time. This time the amount of work to be done was cut down to 17,400 ft., the contracts arranged for separate or combined bids on excavation and back filling, hauling, and laying of pipe, and contracts were finally let in May and June, 1920, for 17,400 ft., at $8.26, a total of $143,783.75.

Bids on Filter Plant and Pumping Station

Experience with the filter plant construction was similar to that of the force main. The complete filtration plant substructures, and filter plant equipment, was first advertised with bids to be received on April 26, 1920. One bid was received on the substructure totaling $539,-



GENERAL PLAN AND SECTION OF WATER FILTRATION PLANT FOR ELYRIA, OHIO.

and construction of filters and pump station, it was evident that the amount of work to be done would have to be seriously curtailed.

Pipe Laying Contract

Bids on laying pipe were first opened on Feb. 4, 1920, and resulted in one bid which would have made the total cost of laying $11.59 per ft., and the cost for the entire line of 23,800 ft., $275,840. This bid was therefore rejected, and new bids taken on March 17, 1920, separate contracts being advertised for hauling, trenching, and laying. Four bids were submitted this time, but contractors refused to agree to have their bids for the three contracts considered separately, and it was necessary to reject bids 547, and two bids on the equipment for filters with a capacity of 8 million gallons per day, the lowest bid amounting to $59,130. The substructure bid was unreasonably high and was therefore not accepted, and the filter equipment bid was rejected because it was not considered advisable to contract for the equipment until the substructure was under contract.

Bids were again received on June 21, 1920, for the filtration plant substructure, and filter plant equipment, with the exception of one filtered water reservoir of 1,000,000 gals. capacity, and two filters of a total capacity of 4 million gallons per day. On this advertisement separate bids for construction and materials were asked for,

previous advertising having indicated that certain contractors desired to be relieved of the financial responsibility of purchasing the materials. One bid was received on the construction of the filter substructure totaling $268,634, and several bids on various filter substructure materials, a combination of the lowest bids amounting to about $85,000. Three bids were received on the filter equipment, the lowest bid for construction amounting to $42,305, and for materials to $10,185. With the exception of certain material bids, all other bids were rejected. No bids were received on the construction of the pumping station substructure which was advertised at the same time, and which was as important to get under contract as the filtration plant substructure. Therefore, because it was not considered that the pumping station substructure could be included in the filtration plant substructure bid, the latter was rejected.

The construction contracts for the filtration plant and pumping station substructure were readvertised and bids received on August 18, 1920, the filtered water reservoir and certain other items having been omitted from this advertisement. In order to obtain bids on both the filtration and pumping station substructure, in addition to asking for separate bids, a combined bid was requested on both substructures. Separate bids were received upon the filtration plant substructure totaling $198,144, and the pumping station amounting to $109,705. The separate bids for these two substructures amounted to $307,849, while the combined bid amounted to $291,672, and therefore the latter was accepted.

It was decided to postpone the contracts for filtration plant and pumping station, superstructure, and filter plant equipment until later in the fall or until 1921.

Contractors

The work is now under construction with the East Jersey Pipe Co. supplying the Lock Bar Steel Pipe and Dan Pfahl Co., W. W. Carpenter & Son, and Anderson & Diedrick, contractors on the pipe line trenching, hauling and laying; Lupfer & Remick as contractors on the filtration plant and pump station substructures; and Worthington Pump & Machinery Corp. and Dravo-Doyle Co., contractors for pumping equipment.

Engineers

The work has been designed in the office of Morris Knowles, Inc., under the direction of John M. Rice, M. Am. Soc. C. E., Engineer of Design, and construction is under the supervision of C. W. Tarr, M. Am. Soc. C. E., Mr. H. A. Beck, Director of Public Service is the responsible official in charge for the city, and it is due to his courage and foresight that so much of the projected improvements are going ahead in the face of such formidable difficulties.

NEW WATER WORKS IMPROVEMENTS IN COLUMBUS, OHIO

By John H. Gregory, Consulting Engineer; Professor of Civil and Sanitary Engineering, The Johns Hopkins University, Baltimore, Md.

In the summer and fall of 1908 the City of Columbus, Ohio, completed and placed in operation the last of the series of important water works improvements then undertaken. These consisted mainly of a masonry dam and storage reservoir, a water softening and filtration works, a new pumping station to replace the two existing pumping stations, and duplicate force mains connecting the new works with the distribution system in the city.

Need for Water Works Extension

With the steady growth of the city, Columbus having increased in population from 181,511 in 1910 to 237,031 in 1920, these water supply works have at times of very heavy draft (the city being on direct service) been taxed to supply adequately all of the water needed. This was especially noticeable during the cold winter of 1917-1918, when a maximum peak load of 182 per cent. of the daily average for the year was reached, and also during the hottest part of the summer of 1918, when the maximum peak load ran up to 209 per cent. of the daily average.

Although the maximum peak load did not occur during the winter of 1917-1918, nevertheless, the works were more severely taxed during this cold period, owing to the fact that the total volume of water pumped day in and day out, for several consecutive weeks, was very greatly in excess of the daily average for the year. Doubtless other works in the country, furnishing water by direct service and having practically reached their safe capacity, underwent a similar experience.

Present Water Works

The present water supply is taken from the Scioto River across which stream, at a point about 5.5 miles above the city, a curved masonry dam, about 1,000 ft. long, was built during 1904 and 1905. This dam, which is known as the Scioto River Storage Dam and which raises the water level in the river about 30 ft., forms an impounding reservoir about 5.8 miles long. The reservoir, named the Scioto River Storage Reservoir, has an area of water surface at the elevation of the spillway of about 363 acres; the total storage capacity is 1,720 million gallons of which 1,487 million gallons are available for use.

Below the dam, the river channel carries the water from the reservoir to a point about 4.5 miles downstream where a low intake dam serves to form a pool from which water is raised by low-lift pumps to the water purification works located nearby. At these works, which have a maximum capacity of 30,000,000 gals. daily, corresponding to an average water consumption of 22,300,000 gals., but with piping arrangements which will admit of extension of the works to a maximum capacity of 48,000,000 gals. per 24 hours, sufficient, however, only for an average daily water consumption of 35,000,000 gals., the water is softened, filtered and chlorinated.

From the filtered water reservoir, holding 10,000,000 gals., water is taken to the pumping station in which there are three vertical, triple-expansion, reciprocating pumps, with a total capacity of 65,000,000 gals. per 24 hours, which deliver the water to the city through two 36-in. cast-iron force mains.

Planning Increased Supply

The city was aware that the safe capacity of the works just mentioned was limited, and in the fall of 1918 retained the writer, who was in charge of the design and construction of water and sewerage improvements built in Columbus during the five years, 1904-1909, to make a thorough investigation of the water supply situation, and to report on the best means of furnishing the city with

an increased water supply. This investigation covered several months, and as a result a series of reports were made during the spring and summer of 1919 in which the whole water question was fully discussed and set forth in detail. Definite recommendations were made covering not only the enlargement of certain portions of the existing works but also the construction of additional works at a total estimated cost of $3,000,000. And in the fall of 1919, at the November election, a bond issue of the above amount was authorized by vote of the people.

While in the reports submitted by the writer, recommendations were made covering not only the enlargements and new works absolutely needed at the present time, as well as certain works needed at a later date, it is the purpose of this article to outline briefly only such works as the city proposes to construct in the near future.

Bureau of Water Works Extension

The first definite step taken by the city was to provide for an engineering organization to design and supervise the construction of the work. Accordingly, an ordinance was passed by the city council creating, in the Department of Public Service, under the Division of Water, a Bureau of Water Works Extension, with the following authorized personnel:

Consulting Engineer	
Engineer in Charge	
Office Engineer	
Field Engineers	2
Assistant Engineers	4
Transitmen	4
Rodmen	8
Draftsmen	6
Inspectors	2
Stenographers	2

This bureau, which will function as a part of, and will co-operate with, the Division of Water, has been in operation since the first of May, and appointments under the Civil Service have been made as rapidly as conditions have warranted. It is not expected, however, that the personnel will be complete until active construction of the larger works begins next year. Starting, now, with the supply works, extended investigations clearly demonstrated that, for a very considerable period of years at least, the best interests of the city would be served by building the new storage works on the Scioto River, the present source of supply. It is proposed, therefore, to build a new masonry dam, some miles above the Scioto River Storage Dam and Reservoir, and there impound sufficient water, which, with that available in the present storage reservoir, will provide for an average capacity of 55,000,000 gals. daily of filtered water.

Proposed New Masonry Dam

The new dam, which will be known as the Dublin Dam, will be of the overflow type, approximately 70 ft. in height to the spillway, and something over 1,500 ft. in length, including the abutment sections. The reservoir, which will be called the Dublin Reservoir, will contain roughly 6,575 million gallons of available storage above low water, will have an area of water surface of about 900 acres at the elevation of the crest of the overflow, and will be about 8 miles in length.

The drainage area above the Dublin Dam is about 996 square miles; at the Scioto River Storage Dam downstream, the drainage area is 1,053 square miles.

From the Dublin Reservoir the water will flow down the river to and through the present storage reservoir and thence down the river again to the intake dam where it will be pumped to the purification works by low-lift pumps, softened and filtered, and then repumped by direct service machinery into the force mains connecting with the city distribution system.

Proposed Additional Filters

At the purification works, eight additional filters of 3,000,000 gals. daily capacity each will be built, or a total addition of 24,000,000 gals. daily. This will bring the gross capacity of the softening and filtering works up to a total of 54,000,000 gals. daily, sufficient to provide for peak loads and to allow one filter at any time to be out of commission for inspection and overhauling. The net capacity of the purification works, when enlarged, will be about 35,000,000 gals. daily. At some later date it will be necessary to build additional filters, settling basins, chemical house, etc., to bring the purification works up to an average net capacity of 55,000,000 gals. daily, that for which the supply works will be built.

The storage of filtered water will be increased from 10,000,000 to 16,000,000 gals. by the enlargement of the present clear water reservoir, provision for which was made when the original works were built.

Additional Pumping Equipment

In the pumping station the pumping capacity will be increased by the addition of one low-lift and one direct service pump, each with a capacity of 30,000,000 gals. daily.

The intake dam, which is only a low diverting dam a few feet in height, will be raised slightly to provide a larger pool from which to pump raw water. This will facilitate the operation of the pumping station as larger and larger quantities of water are taken from the river, (in dry weather no water is allowed to run to waste over the intake dam), will increase the screen area in the intake gate house, and will decrease the suction lift on the low-lift pumps.

New Force Main

To provide for pumping larger quantities of filtered water to the city an additional force main 42 ins. in diameter will be laid running from the pumping station to the northerly part of the city, and a 42-in. Venturi meter, with bypass, will be inserted in this line so as to continue metering all of the water pumped as has always been the practice since the new works were started in 1908.

Columbus has been growing rapidly on the high ground to the north, with the result that the pressure has not been such as always to provide satisfactory service at certain hours of the day. To remedy this, a high service district has been created by cutting out a portion of the distribution system and cutting in a high service pumping station with two 5,000,000 gal. daily electrically operated centrifugal pumps. These pumps were installed last year, in a building constructed jointly by the water works and electric light departments, in accordance with the recommendations made at that time.

Reinforcements of the distribution system will be carried out at various points in the city to meet increasing

demands, and additional cross-connections between some of the main feeders will be made.

Briefly then, the above gives a rough outline of the water works program on which Columbus is setting out in order to keep abreast of the growing needs of the city.

Progress on the New Work

In the field, surveys of the dam and reservoir site are under way and boring machines are at work locating the exact surface of the rock and the nature of the covering. In the office, substantial progress has been made in working up studies and designs for such parts of the works as will be first put under construction.

Personnel

The work is being carried out under the general direction of Mr. W. H. Duffy, Director of Public Service, and Mr. Jerry O'Shaughnessy, Superintendent of Water Works. The engineering work is being directed by Mr. C. B. Hoover, Engineer in Charge, Mr. Arthur R. Holbrook, Office Engineer, Messrs. C. B. Cornell and V. C. Norton, Field Engineers, and by the writer, as Consulting Engineer.

FEATURES OF NEW WATER WORKS AT MINOT, NORTH DAKOTA

By Frederic Bass, Consulting Engineer, Minneapolis, Minn., and E. J. Thomas, City Engineer, Minot, N. D.

The City of Minot is located in the northwestern part of North Dakota in the valley of the Mouse River. It is on the main lines of both the Great Northern and Soo Line railroads and serves as a distributing point for an agricultural area within a radius of from 200 to 300 miles to the west, north and east. The population of Minot is at present 10,400, having grown at a steady rate from 6,200 in 1910 and 1,800 in 1900.

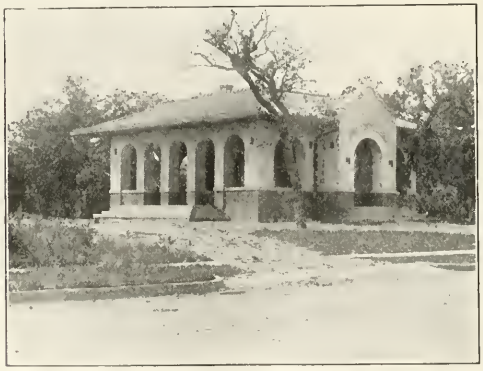


Fig. 1. VIEW OF CITY PUMPING STATION IN OAK PARK, MINOT, N. D.

The need for a municipal water supply was felt in 1900 and in 1904 a supply was introduced from the Mouse River by pumping directly into about 2 miles of 4 in. mains. In 1905 it was realized that a new water supply and distribution system was necessary and test wells were sunk in search of ground water. The results were apparently unsatisfactory and after considerable discussion it was decided in 1908 to use a filtered supply from the Mouse River. In 1909, a new system, consisting of a combined pumping station and rapid sand filtration plant together with 10½ miles of mains, was installed.

This installation was more or less unsatisfactory, due partially to defects in design. As the demands of the growing city increased the plant became inadequate and in 1915 the City Comissioners engaged Prof. H. E. Simpson, Assistant State Geologist, to make a brief survey of

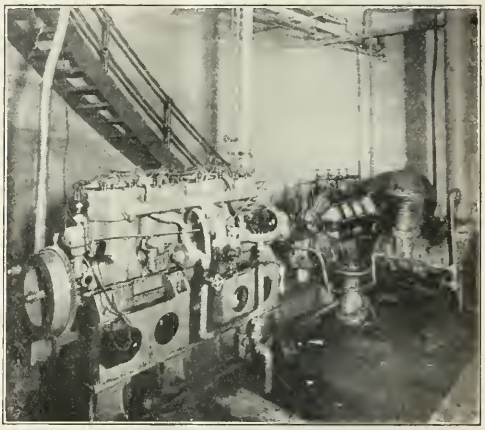


FIG. 2. VIEW OF PUMPING UNIT IN OAK PARK STATION, MINOT, N. D.
Four-Stage Centrifugal Pump Mounted Between 150-H. P. Electric Motor and Reserve Eight-Cylinder Marine-Type Gasoline Engine.

the situation. Professor Simpson advised a more extended study of the situation and in May, 1916, one of the writers, Frederic Bass, was engaged to report on a new water works system for the city. This report was made in November of the same year, after a study of the hydrology of the Mouse River and of the geological conditions. The result was the adoption of a ground water supply.

Ground Water Supply

In the valley of the Mouse River there are found sedimentary deposits of varying character and thickness resulting from the ice sheets which twice invaded this region. Below these are formations of continental origin including lignite deposits and of earlier origin are various clay and marine deposits. Underlying these and extending over nearly the whole of North Dakota is the cretaceous formation known as Dakota sandstone deposited presumably by a great inland lake. It seemed quite possible that the glacial deposits would furnish an adequate water supply, since several small drilled wells were in successful operation; accordingly these were explored.

In the investigation of the sources of supply the surface formation was first examined by means of jetting six 2½ in. test wells from 30 to 60 ft. in depth. These wells sunk at intervals of approximately 100 ft. along the banks of the Mouse River disclosed a water bearing sand, but on account of its extreme fineness a small yield. Two 4 in. and later two 5 in. wells were drilled to depths from 120 to 132 ft. and the coarse sand and gravel found

gave indications of ample water. It was decided to drill a 10 in. well for finally testing the capacity of the source. This was done in the winter of 1916-17 and a test made in March, 1917, gave a yield of 100 gals. per minute. In May of the same year a 12 in. well was drilled to a depth of 132 ft. and a 40 ft. No. 20 brass screen placed. A 100-hour test showed a capacity of 370 gals. per minute. Later when the permanent pumping machinery was installed, a continuous flow of 890 gals. per minute was yielded for a period of one week.

The investigation of the records of stream flow in the Mouse River as determined by Professor Chandler and recorded by the United States Geological Survey showed maximum floods of 2,100 sec.-ft. but for one period of four months in 1910 a mean flow of 0.5 sec.-ft., or 323,000 gals. per day. The demand for water by the city in 1917 was more than twice this amount, and only because of the absence of very dry years had the city already escaped a serious water shortage. It was immediately evident that the Mouse River would not furnish an adequate supply of water for the future. Moreover the ground water would not require filtration and was very much softer, the river water having a permanent hardness of 212 and the ground water 35.

Pumping Station

The necessity of immediately developing the ground water being apparent, the City Commissioners ordered plans made for a pumping station, and a 3,000,000 gal. reinforced concrete reservoir, to be constructed on the hill south of the city at the site of the existing elevated tank. The distribution system already included a 100,000 gal. elevated steel tank on a 80 ft. tower situated on ground approximately 180 ft. above the level of the ground in the major portion of the city. It was planned to divide the distribution system into two zones, all of the water being pumped to the new reservoir at ground level for distribution to the greater part of the city lying in the valley and a small part of the water pumped from this reservoir by two electrically driven centrifugal pumps, float controlled, to the elevated tank to supply the residences on the hill. A considerable saving in power for pumping is thus effected.

The pumping station was located at the 12 in. well in Oak Park. Mr. Andrew Fraser of Minot was engaged as consulting architect and in conjunction with Mr. E. J. Thomas designed the structure which consists of a circular concrete pit 30 ft. in diameter and 25 ft. in depth, surmounted by a pleasing park shelter house 40 ft. by 40 ft. in plan. Fig. 1 shows the character of the structure. The pumping equipment installed consists of a four stage centrifugal pump mounted on a common base between a 150 H. P. motor and an eight cylinder marine type gasoline motor, the latter being kept in readiness for possible failure of electric current. The pumping equipment is shown in Fig. 2.

Reinforced Concrete Reservoir

The concrete reservoir was designed in 1916-17 and constructed in the summer of 1919. On account of the inability of the contractor to finish the construction of the connecting mains the reservoir was not filled with water until June, 1920. It is circular in plan with a diameter of 150 ft. and a maximum depth of water of 22 ft. at the center and 14 ft. at the wall. Figs. 3, 4 and 5 show the design. A flat slab roof designed in accordance with the Chicago building ordinance was substituted for the beam and slab design shown. One feature of the loading of this slab is of interest. It was observed that in the sedimentation reservoir of the old filter plant that a considerable layer of ice resulting from condensation attached itself to the roof and in this design 60 lbs. per square foot was added to the live load to cover this contingency.

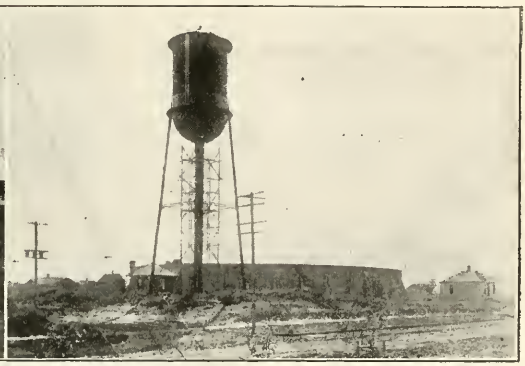


FIG. 3. VIEW OF 3,000,000 GAL. CONCRETE WATER RESERVOIR AT MINOT, N. D. FIG. 4. RESERVOIR, PUMP HOUSE AND ELEVATED WATER TANK AT MINOT WATER WORKS.

The reservoir was filled in the early summer of 1920 and a number of fine vertical cracks opened at irregular intervals in about one half of the panels. It was suspected also, and later verified, that leakage was taking place through the floor. The leakage which at first was as high as 45,000 gals. per day gradually decreased, but it was thought desirable to take measures to water-proof the entire structure on the inside. When the surface had become dry the cracks in the walls and floor were marked and then cut out to a depth of 1 in. and a mastic cement of the General Fireproofing Company troweled in. This cement consisted of a vulcanized chinawood oil holding in suspension asbestos fibre and a small amount of pigment. The entire surface of walls and floor was then painted with two coats of a bituminous paint. Some difficulty was at first encountered in securing a bond between the concrete floor and the paint, due to the difficulty in drying the floor. A thin layer of dry cement

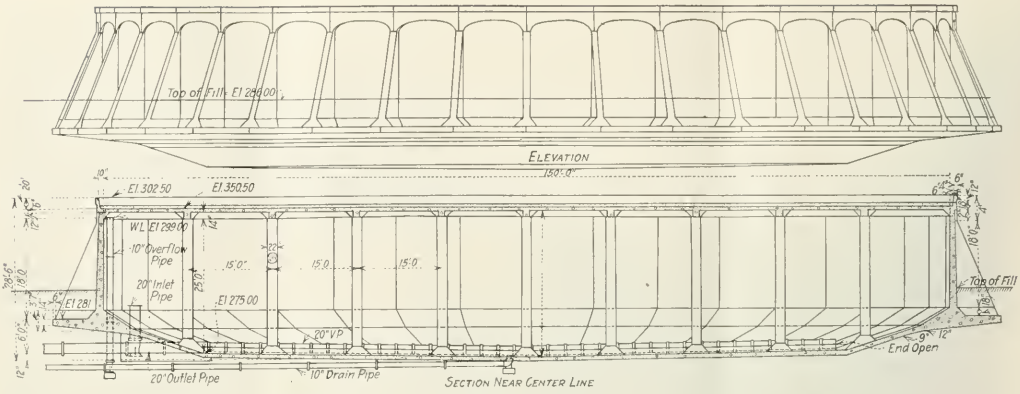


FIG. 5—ELEVATION AND SECTION OF 3,000,000-GAL. WATER WORKS RESERVOIR AT MINOT, NO. DAK.

spread over the floor absorbed the surface moisture and the paint was then applied.

On October 1, 1920, the reservoir was filled after receiving the treatment described. The reservoir is now watertight, showing only four or five damp spots on the outside surface.

POPULARIZING THE WATER UTILITY

By Robert E. McDonnell, of Burns & McDonnell, Consulting Engineers, Kansas City, Mo.

The business of selling water, whether from private or municipally owned plants, with few exceptions, is handled in a manner tending toward bankruptcy and failure rather than toward profits and success, due in a large measure to the failure of the water works officials to consider the public and conduct the water works with the apparent idea that the customers must have the water. Our almost universal practice of ignoring the public is a fault for which we are now paying the penalty, said Mr. McDonnell in addressing the Southwestern Water Works Association.

Publicity Campaigns

Just now, at a time when prices for all water works materials and operating costs are mounting higher and higher and increased rates must be secured, the water works officials, whether private or municipal, are forced to turn to the public and conduct a campaign of publicity of water works facts and information before an unfriendly or hostile public opinion. The facts about water, its purity, the plant and its condition are now given out in a defensive attitude and the lack of familiarity of the consumers with the plant and its needs shows the need of keeping before the public an educational campaign of popularizing the water, light, gas, or other utility. This campaign of publicity would have been easier had it been conducted constantly rather than spasmodically in time of stress.

A large proportion of public clamor against a utility is because the public is not posted as to the facts pertaining to the utility and its relation to the welfare of the citizens.

At the Collector's Window

The knowledge and impressions of the public regarding water works matters are in most cases gained at the water collector's window and through the monthly or quarterly bills mailed out. I wonder how many have ever compared the affability, courtesy, and patience displayed by the clerks selling water with that of the clerk selling dry goods? Can you imagine a clerk in a dry goods store approaching a customer coatless and with a pipe in his mouth? Yet, at a water collector's window such a thing is not unusual.

Friends for a municipal water plant are just as important as for a private enterprise, for on the attitude of these friends depends the character of improvements. Appeals to the public for funds must be constantly made, either new bond issues or tax levies are required in any growing community and the readiness with which the public responds to these appeals depends upon the friendly or unfriendly attitude toward the water works plant and its officials.

A water works official recently said: "We must have new filters, we need new pumps, and we need new mains, but most of all we must have higher rates, but it will be a hard job to convince the public of these necessities because we have silently continued operating, hoping to avoid the necessity of laying our case before the voters."

Undeveloped Territory

In one water plant a fourth of the people along the street were passed by without water connections. One water works individual in an Indiana city, who prided himself on the popularity of his management has discovered that on 100.9 miles of mains there are 2,567 vacant lots, or 48 miles of his extensions front vacant property, all suitable for residences.

Every vacant lot passed is a direct loss, although it is a prospective customer whose acquaintance and connection is needed. Statistics show that for towns of the same population some water plants have as low as 10 services per 100 people, while others as high as 27 services per 100 people. Out of a list of 31 cities in the Southwestern Water Works Association territory it is found that the connections per mile run from 13 to 87, with an average of 50 per mile.

Keep the Public Informed

I find the growth of the water plants, like that of most young children, is all to legs and arms until it becomes

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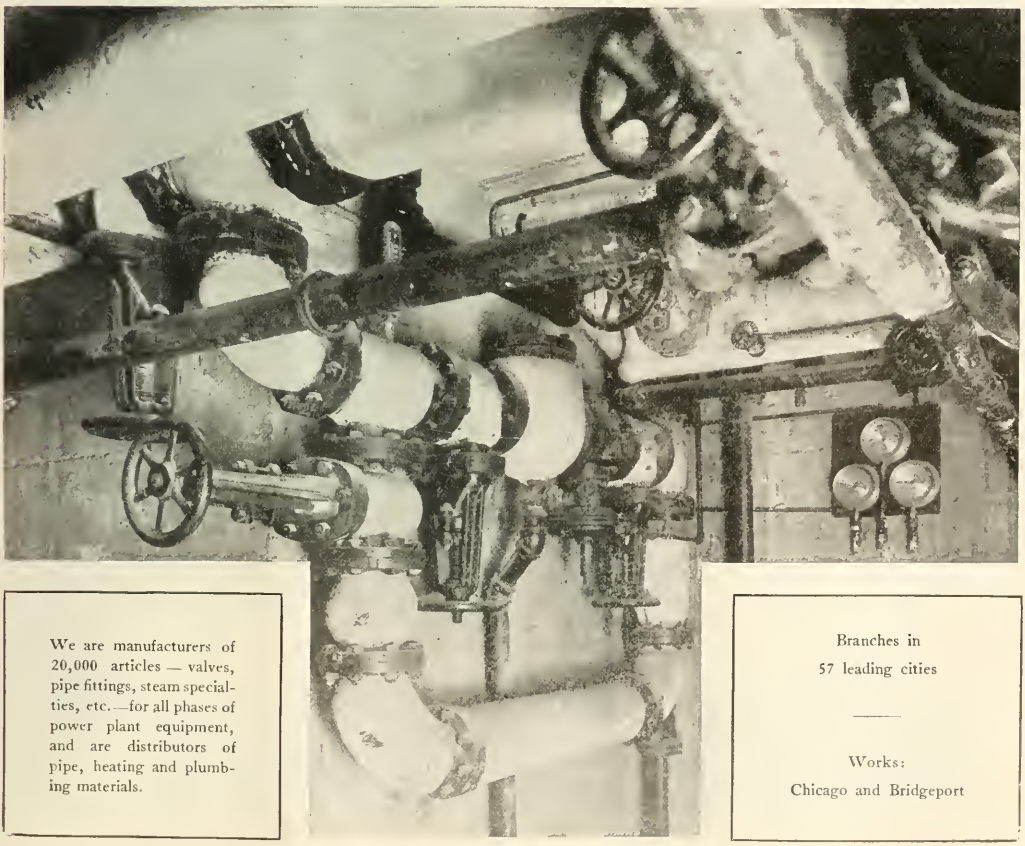

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awkward, with nothing but extensions and no body to supply their wants, and in a few years the vital parts, such as supply pumps, reservoirs, etc., are behind the extensions. Then comes a breaking down of the system and a rehabilitation is necessary, which is doubly hard because the public must be told how and why it happened and the deterioration of the plant is often one that could have been avoided by constantly watching its growth, acquainting the public with the evidences of its inadequacy and providing for betterments before conditions became acute. This can best be accomplished by a complete program of future growth, showing what the plant will need in order to supply its growing condition. Let this program of growth go before the public in every possible way so there will be no shocks or surprises. Your rate of consumption from year to year, your rate of extension of mains, your pump capacity requirements, in fact every feature of the plant can be compared in graphical diagrams and curves showing the plant's needs. Supply them as news items on folders accompanying bills, as cartoons, and on the receipted cards. For example, Omaha never lets the public forget the saving resulting in the municipal ownership and operation of that plant, for the same rate charged under private ownership is still printed on the cards, and in red ink is printed the reduction in cost of water under municipal ownership.

Pure Water a Great Civic Asset

The most common ailment of water works plants is that produced by permitting impure water to go into the mains. Pure water is an asset that no city can afford to be without. If your city does not have pure water you are without the essential qualifications of making the plant a success. After a pure water supply is established the publicity regarding its purity should always be kept before the public. The U. S. Public Health Service has fixed a high standard and when a water plant meets their requirements and sells water for train service this fact should be made known. Photographic bacteria plates illustrating the difference between the raw water and purified water, as per illustration, are always convincing and interesting to the public. Bottled waters are often sold where they are inferior to the quality sold from the water works plant. At Bay City, Mich., recently the bottled water companies carried large display ads telling of the bacteria in the city water. At Tulsa it is reported that bottled water sales exceed the revenue from the municipal filter plant. By a campaign of publicity from a city or company having pure water, there ought not to be a drop of bottled water sold.

Milk companies of many cities have recently inaugurated advertising campaigns to popularize milk, giving cartoons showing beautiful and healthful children, attributing everything to pure milk. Their statistics are convincing. The U. S. Department of Agriculture popularizes by cuts, drawings, pamphlets, and photographs, before farmers, the need of pure seeds. Pure water has more good sound arguments as a basis for advertising and popularizing than any other commodity.

PHOTOGRAPHS OF BACTERIA PLATES SHOWING DIFFERENCE BETWEEN RAW, SETTLED AND FILTERED WATER.

At the Tulsa meeting of this Association, nearly three years ago, my sanity was somewhat questioned when I predicted greatly increased prices in all water works materials as soon as the Government removed the war time restrictions, and we have in the last five years experienced increases even greater than then predicted.

Price Advances

The following percentages of increase in the water works materials and labor is derived from figures from more than 100 water works officials in 36 states: Cast iron pipe increase, 245%; special castings increase, 191%; lead increase, 88%; meters (¾ in.) increase, 37%; valves (6 in.) increase, 107%; and coal increase, 98%.

Average increase in superintendents' salaries, 37%.

Average increase in other employees' salaries, 57%.

The alarming feature of the investigation shows that 79% of the 100 cities have received no raise of rates, yet practically all of the cities are in urgent need of an increase. Of the 21% of the cities securing a raise of rates, the average increase has been 49%.

The one fact preventing a uniform raise of rates to meet the corresponding increase in other commodities is the lack of public knowledge regarding the needs of the plant, its true condition, its value in dollars as a basis of

Look Ahead!

Service Measured by Centuries

YOUR town of to-day will be the city of to-morrow.

Make a liberal allowance for this growth and install Cast Iron Pipe of ample capacity.

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1 BROADWAY, NEW YORK

rates and as an asset to the community, which facts ought to be clearly set forth and kept constantly before the public. If comparisons were made for use of the individual in the costs of all ordinary commodities, it would be found that water, although the most essential of all commodities is the lowest in cost.

If you will compare your meat bill, bread bill, fuel bill, picture show bills, or cigar bill with your water bill you will find the water the lowest of all.

You Tell 'Em, Bryan

Water needs popularizing both for the sake of our own health and happiness and for the future success of the water works business. We have now enlisted as a popularizer of water the great Commoner, W. J. Bryan, who recently said, "All hail to the drink of drinks—to water, the daily need of everything! It ascends from the earth in obedience to the summons of the sun, and descends in showers of blessing. It gives forth its sparkling beauty to the fragrant flowers; its alchemy transmutes base clay into golden grain; it is the radiant canvas upon which the fingers of the Infinite trace the rainbow of promise. It is the beverage that refreshes and brings no sorrow with it. Jehovah looked upon it at Creation's dawn and said, 'It is good.'"

NECESSITY OF COMPETENT SUPERVISION AND CAREFUL LABORATORY CONTROL IN OPERATING WATER PURIFICATION PLANTS

By Lewis I. Birdsall, Superintendent of Filtration, Waterworks Department, City Hall, Minneapolis, Minn.

Eternal vigilance is the price of pure water. Every water purification plant, from the smallest liquid chlorine installation to the largest and most complete filtration plant, should be operated under competent supervision and careful laboratory control.

Neglecting Small Chlorinating Plants.

The cheapness and demonstrated effectiveness of liquid chlorine, as a sterilizing agent for water supplies have induced many waterworks officials in Minnesota, as elsewhere in the United States, to rely on chlorine as the sole means of water purification. Such an installation may, however, merely afford a false sense of security. Failure to keep up the chlorine treatment continuously and in amount sufficient for sterilization of the water may mean a typhoid fever epidemic in the community. This danger is greatest among the smaller water works plants, where one man is frequently responsible for the operation of the pumps and the chlorine machine. The result is that the pumps get most of his attention and the chlorine machine is neglected.

Duplicate Installations of Liquid Chlorine Machines Are Imperative

There are many water works plants, and among them some that are not small plants, that rely for chlorine sterilization on one machine only, so that when it is necessary to change chlorine cylinders or to make necessary repairs, the chlorine feed has to be discontinued. Too much stress can not be placed on the necessity of duplicate installations of liquid chlorine machines wherever used so that when one machine is taken out of service the other may be put in service immediately and continuous treatment be obtained. There should also be kept on hand a supply of extra parts for the chlorine machines, so that ordinary repairs may be quickly made in case of emergency. Our state boards of health should require duplicate installations of liquid chlorine machines, and it would also appear that the manufacturers of the machines might be led to see the advantage to themselves, as well as to the various communities served, in making a substantial reduction in the selling price of two machines to the same purchaser as compared with the price of one machine. The price of repair parts should also be kept as low as possible, and all users of the machines be urged to keep a supply of extra parts on hand.

Chlorine cylinders that are in service should be placed on scales and a record be kept of the weight of the cylinders every hour, not only as a check on the manometer gauge of the chlorine machine, but also to accustom the operators of the plant to inspect the machines frequently to see that they are working properly. The scales prevent chlorine cylinders from going empty unexpectedly and the recorded weights serve as a check on the faithfulness of the operator, provided that the amount of water treated each hour is accurately determined.

Amount of Chlorine to Use.

But how shall we know that we are adding the proper amount of chlorine to the water in order to obtain sterilization at all times? There is no general rule for the amount of chlorine to use. The suspended matter, dissolved organic matter and the bacterial content of surface waters, especially river waters, are constantly changing. The amount of chlorine necessary for sterilization of the water is influenced by all three of these factors. A filtered water or a fairly clear and pure water requires less chlorine than does a turbid water, or one containing a large amount of dissolved organic matter. Whereas a treatment of three-tenths of one part per million (two and one-half pounds of chlorine per million gallons) may be satisfactory in the first case a much larger dose is required in the latter instance. Residual tastes and odors must be considered in the treatment of some unfiltered waters. A slight variation in the amount of chlorine added may mean either under-treatment and lack of sterilization or over-treatment and complaints from the water consumers. Sterilization takes place less readily in cold water than it does in warm water and so it is necessary to allow a longer period for the reaction in winter than in summer. Experience has shown that free chlorine disappears much more rapidly from the treated water when the water is passed through iron pipes than when it goes through a concrete conduit.

Laboratory Control Essential to Chlorine Regulation.

It is evident that in order properly to regulate the chlorine treatment there must be laboratory control. The test for free chlorine in the treated water, and the determinations of the number of bacteria and the presence or absence of B.coli in the untreated and treated waters offer such control tests. Because of the lag of forty-eight hours in the results of the bacteriological tests, made necessary by the incubation of the inoculated media, it is advisable, in most plants, to add sufficient chlorine to the water to produce a slight residual free chlorine content of approximately 0.05 part per million. Some waters,

as stated above, do not permit of over treatment, but such waters are comparatively few, and where they occur the treatment requires very careful supervision. In the majority of cases, therefore, the chemical test for free chlorine becomes the one on which we rely for sudden changes in the chlorine treatment and the test should be made several times each day. The bacteriological tests indicate the results of the treatment and demonstrate the purity of the treated water. They should be made daily on both the untreated and treated waters.

Chlorine is comparatively cheap, much cheaper than human lives, and therefore it is much more desirable to over-treat a water supply with chlorine than to under-treat it if reliance for purification is placed on chlorine alone. A chlorine taste in the water, even though it may be unpleasant is less harmful to the water consumers than a tasteless water that contains typhoid bacilli.

Chlorine sterilization is a valuable adjunct to other methods of water purification, but it should not be depended upon as the only line of defense between a seriously polluted water supply and the water consumers unless it is so used as a temporary expedient and then only under the most careful supervision.

Laboratory Control of Filter Plants.

The laboratory tests necessary for the control of a filter plant are more comprehensive and elaborate than those described for a chlorine plant.

Turbidity, color, alkalinity and the bacterial content of the untreated water usually determine the amount of chemical necessary for proper coagulation of the water before it goes to the filters. The same tests on samples of the water as it goes to the filters from the coagulation basins determine the efficiency of the pre-treatment. A properly coagulated and filtered water should have no turbidity and a color of ten parts per million or less. The bacterial content of the filtered and sterilized water should be as near zero as possible and B.coli should be absent in 50 cc. amounts of the water.

An odor in the untreated water may be caused by algae and a microscopical examination of the water will disclose the offending organism. Odors from manufacturing wastes are sometimes more difficult to eliminate from the water than are those from micro-organisms. Tests for odor should be made on both the untreated and the filtered water.

The alkalinity test demonstrates the presence of carbonates and bicarbonates in the untreated water and whether or not they are sufficient in amount to decompose the coagulant to be added. The filtered water should at all times have residual alkalinity as a safeguard against the presence of undecomposed coagulant.

Free carbonic acid frequently occurs in surface waters. A determination of the amount present should be made where lime is used in conjunction with iron sulphate as coagulant. The amount of free carbonic acid in the filtered water should be determined because of the part it plays in the corrosion of exposed iron surfaces in distribution pipes.

The test for residual chlorine is essential as already described.

Total hardness tests are made at intervals for the purpose of record. Complaints regarding the hardness of the

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water supply are more easily answered if data is at hand to show that the filtered water is no harder than the untreated water and that the hardness of the water is greater at certain times of the year, due to natural causes.

Complete sanitary chemical and mineral analyses of the untreated and filtered waters are made each month in the larger filtration plants for the purpose of record. These are not necessarily essential for the purpose operation of the plant, but they are of value for reference.

Analyses of the chemicals used for water purification are valuable and there should be frequent tests of the chemical solutions that are added to the water.

The Most Essential Laboratory Tests for Filter Control.

The most essential laboratory tests for the proper control of a filtration plant are those for turbidity, color, alkalinity, residual chlorine, number of bacteria per cubic centimeter and B.coli. The data obtained from these tests will enable the operator to handle his plant economically and efficiently. He will, at all times, have the satisfaction of knowing the quality of the untreated water and the degree of purification obtained by the plant. The health of a community is the final test by which the purity of a water supply is judged, but the operator of a water purification plant, who knows each and every day that the water he is supplying is of the highest purity, has nothing to fear from health statistics.

A water softening plant requires certain special laboratory tests in addition to total hardness, alkalinity and free carbonic acid determinations. Only under laboratory control can a softening plant be properly operated.

It seems almost inconceivable that anyone should attempt to operate a water purification plant without daily laboratory control tests, but experience has shown that many plants are so operated. An occasional bacteriological analysis of a water supply, whether monthly or weekly, has little significance. It merely shows the condition of the water at the time the sample was taken. The splendid work of the Sanitary Division of the Minnesota State Board of Health is tending to raise the standard of water purification plants in Minnesota and to demonstrate that the saving of human lives rather than dollars is the high ideal we should have constantly before us.

Short Courses at Universities for Water Works Men.

Texas has set an example to other states by organizing a short course for water works superintendents and purification plant operators at the University of Texas. The local sections of the American Water Works Association can do no greater good for their communities than by stimulating interest in the organization of similar courses of instruction in their state universities and then urging the water works men to attend these courses. The farmers, long ago, realized the value of short courses at the state university and now attend them annually. Why can not the universities do for the water works men what they have done for the farmer? The possibilities for education in this new field are unlimited.

Simple Tests for Small Plants.

Many small water purification plants are unable to pay the salary of a competent analyst. Such plants no doubt have some employe who could learn to perform some of the more simple routine tests, such as turbidity, color, alkalinity and free chlorine, provided that the necessary chemical solutions are prepared for him. The bacteriological tests are somewhat more difficult, but even these can be performed by such an employe if he shows an aptitude for the work and provided that the necessary media can be furnished. A competent water purification expert could, no doubt, be employed by a number of such plants at a comparatively small expense to train the operator, interpret the laboratory results thus obtained, furnish the necessary chemical solutions and bacteriological media, supervise the general operation of the plant and visit the plant periodically. Such an arrangement obtains in some sections of the United States and has been found to work very satisfactorily.

A water purification plant that is operated without laboratory control is merely furnishing a false sense of security to the community. The same plant, when operated under laboratory control and competent supervision, can and should yield a safe and pure water at all times.

The foregoing paper by Mr. Birdsall was presented at the Rochester meeting of the Minnesota section of the American Water Works Association in December, 1919.

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Construction News and Equipment

DATA ON SIX 1920 HIGHWAY CONTRACT LETTINGS IN NEW YORK

The accompanying tables give in convenient and condensed form information regarding the first six 1920 contract lettings of the New York State Highway Commission. They show the amount of work advertised, the number of bids received, the average cost per mile for each type as estimated by the Commission, and the actual average cost as shown by the low bids.

As the Commission distributed a circular under date of Dec. 31, 1919, giving estimates of costs on different pavement types, these estimates are also shown upon the tables for ready comparison with the actual costs.

NEW YORK STATE—LETTING OF JAN. 30, 1920

Projects 1529, 1538, 1539, 1540, 1419, 1533, 1228-A, 1542, 1389, 1388, 1545, 1546, 1467, 1526, 451-A, 1321-A, 1452, 1352, 1480, 1537, 773-A.

Completion Contracts

	Cement Concrete	Bituminous Macadam	Water Bound Macadam
Number of projects	15	4	2
Mileage	56.63	26.18	15.11
Bids received—No. of projects	7	3	2
Bids received—Percentage of mileage	26%	80%	100%
Av. Engineer's estimates per mile complete	$32,929	$18,277	$15,963
Av. low bid price per mile, complete.	37,969	14,820	15,614
Average estimates for surface published by Comm. 12/31/1919....Light —	24,363.76	22,155.56	
Heavy—	28,544.12	28,599.61	

NEW YORK STATE—LETTINGS OF MARCH 18, 1920

Projects 1533, 1532, 1438, 1542, 1389, 1547, 1548, 1383, 1545 1546, 1520, 1553, 1554, 1551, 1555, 1549, 1550, 5655, 1429, 1552, 1471.

Completion Contracts

	Cement Concrete	Bituminous Macadam	Water Bound Macadam
Number of projects	14	6	1
Mileage	62.61	26.28	6.96
Bids received—No. of projects	8	6	None
Bids received—Percentage of mileage	62%	100%	.....
Av. Engineer's estimate per mile, complete	$35,556	$27,114	$29,368
Av. low bid price per mile, complete.	31,596	26,367	.....
Average estimates for surface publish by Comm. 12/31/1919.....Light —	24,363.76	22,155.56	
Heavy—	28,544.12	28,599.61	

NEW YORK STATE—LETTINGS OF APRIL 16, 1920

Projects 1529, 1530, 1385, 1442, 1449, 1358, 1359, 1556, 5653, 1557, 1321, 1550, 5657, 1471 (No. 1559, consisting of two types, omitted)

Construction Contracts

	Cement Concrete	Bituminous Macadam	Water Bound Macadam
Number of projects	9	4	1
Total mileage	25.67	13.05	8.34
Bids received—No. of projects	4	1	1
Bids received—Percentage of mileage	39%	18%	100%
Av. Engineer's estimate per mile, complete	$39,205	$27,851	$29,034
Av. low bid price per mile, complete.	41,430	32,712	28,481
Average estimates for surface published by Comm. 12/31/1919....Light —	24,363.76	22,155.56	
Heavy—	28,544.12	28,599.61	

The tables show that New York State is paying $13,000 per mile more for cement concrete than for bituminous macadam, that the percentage of mileage of bituminous macadam upon which bids have been received is almost double that for cement concrete, and that the actual relative costs of these two types is very different from that shown by the Commission's estimates of last December.

In comparing these costs and estimates it should be noted that some of the concrete is reinforced and some is not and that some has an average thickness of 5½ ins. and some 6½ ins. The thinner is believed to predominate.

NEW YORK STATE—LETTINGS OF APRIL 16, 1920

Projects 1245, 1247, 1248, 1249, 1232, 1234, 1235, 1241, 1242, 1240, 1244, 1250, 1251, 1233, 1239, 1237, 1238, 1243.

Repair Contracts

	Cement Concrete	Bituminous Macadam	Bituminous Concrete	Heavy Bit. Surface Treatment
No of projects	14	1	1	2
Total mileage	39.73	3.00	4.33	4.41
Bids received—No. of projects	10	1	1	2
Bids received—Percentage of mileage	65%	100%	100%	100%
Av. Engineer's estimate per mile, complete	$31,764	$14,663	$19,010	$6,268
Av. low bid price per mile, complete	30,377	14,263	18,863	5,880
Av. estimates for surface published by Comm. 12/31/1919 ...Light —	24,363.76	22,155.56		
Heavy—	28,544.12	28,599.61	32,554.89	

NEW YORK STATE—LETTINGS OF MAY 5, 1920

Projects 5645, 1533, 5639, 1482, 1515, 5641, 5659, 1467, 5654, 1552, 1561.

Construction Contracts

	Cement Concrete	Bituminous Macadam
Number of projects	9	2
Total mileage	31.08	8.70
Bids received—No. of projects	Withdrawn by Comm.	
Av. Engineer's estimate per mile, complete	$40,210	$33,945
Average estimates for surface published by Comm. 12/31/1919 .....Light —	24,363.76	22,155.56
Heavy—	28,544.12	28,599.61

NEW YORK STATE—LETTINGS OF MAY 5, 1920

Contract Nos. 1254, 1253, 1246, 1255, 1236, 1264, 1256, 1262, 1263, 1252, 1258, 1259. (No. 1257—two type project omitted)

Repair Contracts

	Cement Concrete	Bituminous Macadam	Bituminous Slag	Light Bituminous Surface Treatment
No. of projects	9	1	1	1
Mileage	22.39	2.69	2.31	45.42
Bids received—No. of projects	6	1	1	1
Bids rec'd.—Percentage of mileage	67%	100%	100%	100%
Av. Engineer's estimate per mile, complete	$25,510	$15,625	$19,061	$694
Av. estimates for surface published by Comm. 12/31/1919 .. Light —	24,363.76	22,155.56		
Heavy—	28,544.12	28,599.61		

SUMMARY OF SIX 1920 NEW YORK STATE HIGHWAY LETTINGS OF JAN. 30, MAR. 18, APR. 16, MAY 5, JUNE 7 and JULY 2 ON COMPLETION, CONSTRUCTION AND REPAIR CONTRACTS

	Cement Concrete	Bituminous Macadam	Bituminous Concrete	Waterbound Macadam	Light Bit. Surf. Treat.	Misc.
No. of projects advertised	90	22	1	4	2	9
Mileage	280.43	92.90	4.33	30.41	127.54	21.21
Bids received—No. of projects	48	15	1	3	2	....
Bids received—Percentage of mileage	47%	72%	100%	77%	100%	....
Av. Engineer's estimate per mile for 1920 projects, complete	$34,849.00	$24,222.00	$19,010.00	$22,613.00	$615.00	....
Av. Low Bid price per mile, complete for lettings of Jan. 30, Mar. 18, Apr. 16, June 7 and July 2	$33,961.00	$20,876.00	$18,863.00	$20,105.00	$551.00	....
Average estimates for surface alone published by Commission, Dec. 31, 1919....Light —	$24,363.76	Light —$22,155.56	.....	.....	.....	....
Heavy—	$28,544.12	Heavy—$28,599.61	$32,544.89	.....	.....	....

Printed as insert to Municipal and County Engineering, Chicago, Ill., October, 1920.

NEW YORK STATE—LETTING OF JUNE 7, 1920

Contract Nos. 1269, 1260, 1271, 1272, 1270, 1275, 1274, 1280, 1253, 1261 1246, 1277, 1273, 1257, 1235, 1281, 1279, 1276, 1258.

Repair Contracts

	Cement Concrete	Bituminous Macadam	Asphalt Block & R. C. Concrete & Bit. Macadam	Willite	Light Surface Treatment
Number of projects	13	2	2	1	1
Mileage	29.66	6.97	4.87	1.04	82.12
Bids Received—No. of projects	9	1	2	1	1
Bids Received—Percentage of mileage	72%	58%	100%	100%	100%
Av. Engineer's Estimate per mile, complete	$36,418	$20,642	$41,616	$22,428	$571
Av. low bid per mile, complete	34,641	19,708	40,815	22,122	551
Average Estimates for surface published by Comm 12/31/1919 — Light	24,363.76	22,155.56			
Heavy	28,544.12	28,599.61			

NEW YORK STATE—LETTING OF JULY 2, 1920

Contract Nos. 1282, 1269, 1260, 1268, 1274, 1208, 1261, 1277, 1225, 1248.

Repair Contracts

	Cement Concrete	Bituminous Macadam	Misc.
No. of projects	7	2	1
Mileage	12.66	6.03	1.50
Bids Received—No. of projects	4	2	0
Bids Rec'd.—Percentage of mileage	52%	100%	
Av. Engineer's Estimate per mile, complete	$40,472	$28,274	$51,820
Av. Low Bid price, per mile, complete	39,826	27,500	
Av. Estimates for surface published by Comm. 12/31/1919...Light —	24,363.76	22,155.56	
Heavy—	28,544.12	28,599.61	

While the specifications for cement concrete during the early part of 1919 customarily called for 1 part of cement to 4½ parts of sand and stone, the practice adopted later in the year which applies on the 1920 work provides for a leaner mixture calling for 1 part of cement to 6 of sand and stone.

The minimum bituminous macadam was announced by the Commission's circular to be 11 ins. in thickness but it is stated that Division Engineers received instructions early in the year to increase this to 15 ins.

Of the total mileage for which bids have been received at these six lettings, 116 miles are completion contracts and less than 21 miles new construction. The balance are repair contracts.

The tables were compiled from the regularly issued notices and tabulations of the Contractor's Service Office at Albany.

UNIT COSTS ON NORTH CAROLINA HIGHWAYS

The following information with respect to current prices of road construction in North Carolina was released on Sept. 7, 1920, by the North Carolina State Highway Commission. The figures quoted are the prices at which contracts have recently been let in that state:

Clearing and Grubbing, per acre	$75.00	$150.00	$200.00
Common Excavation, cu. yd.	.54½	.58	.55
Borrow Excavation, cu. yd.	.54½	.58	.58
Solid Rock Excavation, cu. yd.	1.90	2.25	
Top Soil Surfacing, cu. yds.	.75	.72	.70
15-in. Terra Cotta Pipe, lin. ft.		2.10	2.00
18-in. Terra Cotta Pipe, lin. ft.	2.00	2.75	3.00
20-in. Terra Cotta Pipe, lin. ft.			
24-in. Terra Cotta Pipe, lin. ft.	3.00	4.00	4.00
16-in. Corrugated Pipe			3.50
18-in. Corrugated Pipe			4.00
Concrete Headwalls, Class B, cu. yd.	35.00	30.00	30.00
One Course Gravel Surfacing, cu. yd.	2.00		
Overhaul	.01	.04	.04
Concrete Structures, Class A	35.00		
Reinforcement Steel	.11		
Bolts and Plates	.11		

PATENT APPLIED FOR ON IMPROVEMENT TO AUSTIN CUBE MIXER DRUM

Application has been made to the U. S. patent office for an improvement on the Austin Cube Mixer drum. Strong claims are made on speed of mixing, loading and discharge. The new design is called the Cube-Hex and the mixing action is increased by the addition of six extra planes which throw the concrete across that thrown by the six side planes. The claims are that dry mix, specified by many states, is much more quickly mixed than even by the cube shaped mixers used by the U. S. government at Panama Canal Locks.

BUILDINGS FOR VOTING PURPOSES

Owing to the shortage of housing facilities, and other sundry causes, it has been found difficult in many localities to provide suitable buildings for election purposes.

The solution of this oft-times perplexing problem has been found in a standardized, portable steel building recently placed on the market by a large steel building manufacturer. The advantageous feature of this building is its portability—its standardized design permits quick dismantling with ordinary labor and transportation to another locality in either a wagon or truck. This feature is especially desirable because of changing voting places in different precincts.

QUIXET VOTING PLACE.

This building is made of steel throughout; the structural framework, the galvanized sidings, steel window frames and sashes, and kalameined doors, give rigid and durable construction which means almost the entire elimination of maintenance expense. When not in use as voting places, these buildings could serve to provide storage facilities for county road building equipment.

The Blaw-Knox Company of Pittsburgh, in placing this building on the market, has opened the way to a considerable ultimate saving in building costs and rentals which is well worth some thought.

Champion Snow Plow attached to a Sauer Truck. Used by the City of Brooklyn, N. Y.

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There are no traffic tie-ups or periods of suspended business through snow falls, in the town, city or state, adequately equipped with Champion Snow Plows.

Easily and quickly attached to any standard motor truck, Champion Snow Plows offer a modern, economical and never-failing method of snow removal under all conditions. When not in use they can be removed from the trucks which are then available for other uses.

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The P & H Excavator-Crane is capable of performing the four general functions of Excavating, Grading, Backfilling and Material Handling. The four major uses of this equipment by road builders are as follows:

Grading Roads. Where roadbeds are low and need "shouldering up," or where fill must be made through water-logged and swampy land, the P & H Excavator-Crane will pull in and heap up the ground much faster and cheaper than will teams and graders.

Making Cuts. The P & H will make cuts in roads at the rate of 300 to 500 yds. per day. The average cost seldom exceeds $20 for a day's operation. When the excavated material is loaded in wagons, the capacity is reduced only about 10 per cent. For constructing drainage ditches the P & H is run alongside or center of the completed road, excavating the ditches to the required depth and wasting the dirt on the slope of the roadbed or beyond the ditch. On this operation the machine cost is rarely over 8 cts. per yard, even when handling wet earth where it is often impossible to work teams.

Excavating Gravel. Capacity (approximate) 300 to 500 yds. per day of gravel from the bank into trucks and wagons. The hauling equipment, working with a P & H, is never in the excavated hole as it is with steam shovel or trap loading. The P & H Excavator-Crane has a full circle, non-obstructed swing with an operating radius of 30 ft.

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Size of Buckets—½ yd. drag, scraper clamshell, orange peel.
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Length—19 ft. 9¼ ins.
Weight—14 tons.
Traction Speed—1 mile per hour.
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Tubular Type Radiator—Latest heavy truck design.
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12	9,800
16	6,900
20	5,200
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30	3,300

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Monadnock Block, Chicago, Ill.
Yeon Bldg., Portland, Oregon
Central Building, Los Angeles
Monadnock Bldg., San Francisco
L. C. Smith Building, Seattle, Wash.

"You see them wherever you go, and they go wherever you see them."

P&H — excavators — back-fillers - tampers

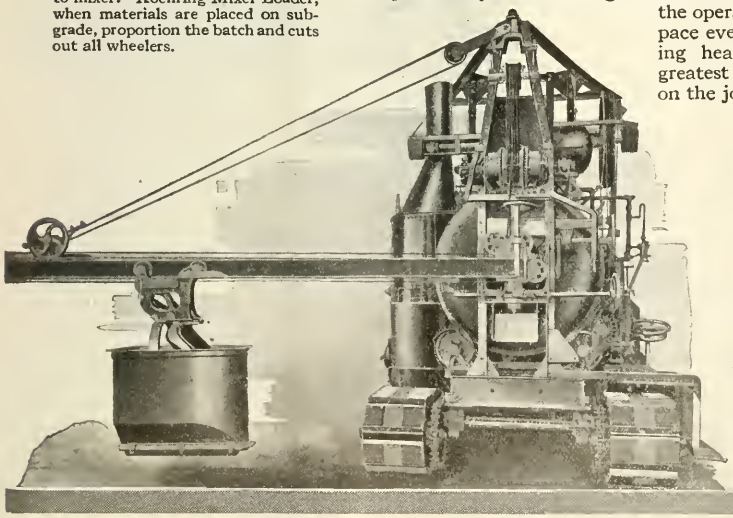
KOEHRING

Koehring loading derrick part of Koehring mixer equipment when batches are made up at central loading station and brought to mixer in batch boxes on industrial cars and trucks.

Long narrow design of Koehring Pavers gives extra room on subgrade to bring industrial car close to mixer. Koehring Mixer Loader, when materials are placed on subgrade, proportion the batch and cuts out all wheelers.

EXTRA yardage, every day, means extra profit—because the Koehring is the fastest paving unit—the mixer of liberal drum dimensions, fast loading and discharging, and with Koehring boom and bucket, the fastest distributor of any consistency of concrete.

It's the fastest paving **unit** because these fast operations are made possible by the Koehring exclusive automatic actions which enable the operator to keep up the high speed pace every minute of the day. Koehring heavy duty construction is the greatest profit-insurance you can put on the job.



KOEHRING SIZES

In cubic feet mixed concrete

Construction Mixers: 4, 7, 10, 14, 21, 28, Steam and Gasoline.

Paving Mixers: 10, 14, 21, 28. Boom and Bucket and spout distribution, caterpillar traction, loading derrick, steam and gasoline.

Write for Paver catalog.
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Koehring Machine Company

Milwaukee Wisconsin

Sales and service office in all principal cities.

THE SUB-GRADE AND ITS RELATION TO ROAD SURFACING AND TRAFFIC

The Federal Highway Council Committee on Sub-Grade and its Relation to Road Surfacing and Traffic presented the following preliminary report at the conference meeting of the various committees of the Council, held at Akron, Ohio, on Sept. 27 and 28, 1920:

The conditions of traffic have undergone a very radical change during the past several years. We have seen the weight of the individual unit of traffic gradually increase so that at the present time, many of our roads are forced to carry motor trucks having a capacity of 7½ tons. As a result the wheel concentrations on the road surface combined with lack of supporting value of the underlying subgrade have resulted in structural failures of every type of road constructed up to the present time.

Eliminating Road Failures Due to Poor Foundations

The problem of eliminating road failures due to poor foundations seems to be possible of solution in one of the following ways:

1. Make the road surface thick enough so that the pressure from heavy traffic will be sufficiently distributed to the underlying subgrade, or so that the surface because of its inertia may absorb a considerable amount of the shock of traffic.

2. Design the slab to have sufficient strength to bridge over the soft subgrade.

3. Improve our drainage systems to exclude moisture in sufficient amounts from soils which are rendered of very low bearing value by the presence of moisture.

It is perhaps true that most soils have adequate bearing value when they have a sufficient low percentage of moisture or it is not impossible that some soils will be susceptible of treatment, either chemically or mechanically, which will render them of a higher bearing value than they have in their natural condition.

Knowledge as to how to treat types of soils so as to stabilize them and render them of the highest value, is at present non-existent, and it is the purpose of this subgrade committee to make such studies as are necessary to throw light on the methods of treatment of subgrades so as to make them of adequate supporting value for the various types of road surfaces.

Your committee feels that the most important problem from the standpoint of road design at the present time is that of determining means for increasing the supporting value of the subgrade.

We feel that a very intensive study must be made to discover, first, the underlying cause of weak subgrades and, secondly, discover means for correcting poor subgrade conditions.

The field to be covered by this committee is exceedingly large and to accomplish the desired results in the shortest possible time, it is necessary to sub-divide our committee into a number of problem committees, each problem committee to study a particular phase of the subject.

Problems to Be Studied

The following problems have been outlined as subjects to be studied by the various committees:

Problem 1—(a) Obtain samples of subgrade material at points where failures have occurred; also obtain samples from the same road of like construction and like traffic where failures have not occurred. Data accompanying the samples should contain information as to the typography, type of drainage, character of construction, and all other information having relation to the condition of the road.

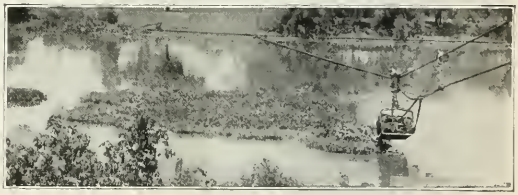
(b) Make physical examination, bearing value tests and such other investigations as may be suggested with data furnished.

Problem 2—Developing Field Tests for Bearing Power of Soils.

Problem 3—Making Studies in Drainage, using experimental sections of roads.

Problem 4—A study of Chemical Methods of Sub-

MATERIAL-HANDLING SIMPLIFIED



THERE is a growing appreciation among engineers and contractors of the fact that the dragline cableway excavator method, so universally employed by commercial gravel-handling plants, can be utilized for other work involving excavating and moving materials over distances of from 100 to 800 feet or more.

The ability of the Sauerman Dragline Cableway Excavator to dig from either above or below water, and to elevate and convey materials from pit to plant without the help of auxiliary machinery, is the reason for its popularity among sand and gravel producers. This same ability makes our type of equipment correspondingly economical and efficient for a wide variety of other material-handling operations, and it is now being successfully used for cleaning reservoirs, building levees, rebanding coal, deepening rivers, reclaiming material from stock piles, loading ballast, etc., etc.

For further information send for our catalog, or lay the details of your problem before us and we will submit our recommendations on equipment.

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FOR STORING AND RECLAIMING
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CARS, TRUCKS AND WAGONS

SAVES 6 TO 12 MEN
SAVES CAR DEMURRAGE

ELIMINATES SHOVEL AND WHEELBARROW WORK
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grade Treatment for Increasing Value or Preventing Absorption.

Problem 5—A Study of Mechanical Methods of Subgrade Treatment.

Problem 6—A Study of Freezing and Thawing on the Volume and on the Supporting Properties of Soils.

Problem 7—A Study of the Effect of Moisture on the Volume Changes in Soils.

Problem 8—A Study of the Transmission of Pressure Transmitted to the Subgrade.

Problem 9—A Study to Ascertain the Practical Classifications of Subgrade Materials.

Problem 10—Special Problems.

In order to expedite the work of the various committees handling these problems, a tentative outline of procedure has been drawn up which will serve as a guide to the sub-committees and enable them to decide in the shortest possible time, on the methods of procedure to be followed by them in their studies.

The various sub-committees are expected to report their proposed procedure to the special advisory committee not later than November 15th and after this date, the sub-committees should be able actively to pursue their various investigations.

There is every indication that the amount of traffic over our roads will be greatly increased in the future and this probably applies particularly to the transportation of freight.

The expenditures involved in the construction of the various road systems is enormous, and it is vital that these roads be built on foundations as stable as it is possible to make them.

It has been pointed out that the subject with which this sub-committee is to deal has many ramifications and it has likewise been pointed out, that it is exceedingly important that we obtain results in the shortest possible time.

An investigation of methods for obtaining high-class construction should very properly be considered as part of any program of construction and it should be emphasized that of the funds appropriated for road construction, there should be set aside an adequate portion for pursuing the needed investigations to make for wise expenditure of these funds.

The importance to all for the hopeful outcome of this work by which our roads should be built more economically and more durably, deserve and should receive every support, especially the undivided support of all commercial interests as they are wrapped up in the superior advantages to them of the early improvement of highways by and through which transportation facilities are increased to a very great extent.

Committee Roster

Chas. M. Upham, Vice Chairman; H. G. Shirley, Secretary; A. T. Goldbeck, Ira B. Mullis, Prof. F. H. Eno, Edward Bridges, D. S. Humphrey, W. P. Blair, Prof. Duff A. Abrams and H. W. Alden.

TELEPHONE STATISTICS SHOW BUSINESS DEVELOPMENT IN SOUTH AMERICA

Srtiking figures showing the development of the South and Central American Republics are made public as a result of a survey by the American Telephone and Telegraph Company. These statistics, which were prepared with the co-operation of the various governments, cover the telephone and telegraph systems of all the countries south of the Rio Grande. The figures are serviceable as indices to the general state of development and of commercial progress in the various American countries and should therefore prove of value to all interested in those countries.

Some of the conclusions reached from this survey are that in the Southern countries the telephone is far from being the universal means of communication that it is in this country and that the main development there is in the big cities, the other areas being very poorly served. The telephone network is about a hundred times as dense in this country, as a whole, as it is there. In point of the number of telephones per hundred of population, the service here is over thirty times as good.

Some of the important points on which latest data are compiled for each of the countries are: Number of telephones and number per hundred of population; mileage of telephone wires; telephone development of the largest city in each country; investment in the systems; gross earnings and unit earnings; telegraph wire mileage, number of offices and number of messages, etc.

The total of 325,403 telephones in all the South and Central American countries, including Cuba and Haiti, should be compared with the 12,000,000 in the United States, which have about the same total population. Argentine leads with 105,205 telephones, or nearly a third of the total. The other countries having more than 10,000 telephones are: Brazil, 67,366; Mexico, 40,211; Cuba, 28,152; Chile, 23,670, and Urugary, 19,486. Haiti, with a total of 2,500,000 people, has 82 telephones.

Only one telephone for about every 300 population is found in the whole area, as compared with 11.39 for every 100 of population in the United States at the same date, or about 34 for every 300 population. Uruguay leads the Latin-American countries in point of telephone density with 1.34 telephones per 100 people. The only other countries having as much as 1 telephone per 100 population are Argentine, Cuba and Panama. In the three countries having the highest telephone development, the systems are almost wholly under private ownership.

The total telephone wire mileage is 905,587, compared with 29,800,000 in this country. Taking into consideration the fact that the total area of the South and Central American countries is 8,476,600 square miles compared with the 3,027,000 square miles of the United States, there is only one-tenth of a mile of wire for every square mile in the Latin countries, while there are nearly ten miles for every square mile here. This means that the telephone network is nearly a hundred times as highly developed here as down there.

The extent to which the countries are served by their systems is indicated by the figures showing the telephone development in the largest city in each country. Habana, Cuba, is the most highly developed, with 5.5 telephones per 100 population. Taking in all of Cuba, however, there is only 1 telephone per 100 people. Mexico City has 3.9 per 100; Mexico as a whole has only 0.25 telephones per 100 population. These figures show how in the Southern countries the bulk of the systems are in the large cities, while the other areas are hardly served at

all. This condition is contrasted with that in the United States. At the same date New York City had 11.7 telephones per 100 people—the United States as a whole had nearly as many, 11.39. Here is adequate service for even the smallest farm communities.

The investment in telephone systems in all the Southern countries together is $64,422,000 compared with $1,600,000,000 in the United States. The per capita investment is 71 cts. in South America compared with $15.09 here. The highest investment is in Cuba, $2.28 per capita. The investment per telephone is perhaps even more significant. In Latin-America there is invested $198 for every telephone in service—in the United States this is only $132. These figures reflect the higher technical progress and the more efficient management, as well as the greater density of development, in this country.

The gross earnings in 1918 of South American telephone systems were only 18 cts. per capita while in this country they were $3.99. The gross earnings per telephone were, however, $52.82 down there and only $34.98 here.

Of the total telephone and telegraph earnings in 1918 in the Latin countries, the telephones brought in only 43.5 per cent. of the total and the telegraph 56.5 per cent. In the United States this situation is strikingly reversed—80.8 per cent. from telephones and 19.2 per cent. from telegraphs. The total telegraph wire mileage is 433,938 down there and 1,900,000 here. The number of offices are 11,627 and 28,900 respectively. The number of messages sent in 1918 was 41,517,200 in the Southern countries as compared with 170,000,000 here.

The telegraph statistics therefore show a more favorable comparison with those of this country than do the telephone figures. The reason is that the telegraph is used more by a specialized class of the population mainly for business. The telephone has not in the Latin-American republics come anywhere near being the universal and democratic means of communication that it is in the United States.

CENTRALIZATION AND INTERCONNECTION OF ELECTRIC POWER PLANTS

By A. L. Mullergren, With Johnson & Benham, Consulting Engineers, Firestone Bldg., Kansas City, Mo.

The ultimate solution of efficient power production in this country is the construction of huge electric power plants at the centers of our natural fuel reservoirs and transmitting the power to the markets by electric transmission lines. It is far more economical to transmit large blocks of power from large efficient power plants to the industrial centers than to transport the fuel by rail to the market centers. There are at present in the United States approximately 6,500 electric power stations having a total rating of 13 million horsepower. Of this amount there is approximately 4½ million horsepower developed from water power. The balance is represented by steam and internal combustion engine plants. A large percentage of the above number of establishments consists of plants of less than 1,000-h.p. capacity.

Some Interconnections Made During the War

During the recent emergency there was quite an advance made in the efficient production of power by the interconnection of existing power plants in order to be able to handle the increased power requirements of the country and to conserve our fuel resources. The few interconnections that were made demonstrated very thoroughly the feasibility and efficiency of this plan. Some of the leading engineers of the country are now advocating very strongly the construction of transmission lines to interconnect more of the present power plants where such interconnections appear economical, and others are urging the construction immediately of mammoth plants at our fuel centers and interconnecting them by transmission lines. The plants that are being advocated would be super-plants having a capacity of from 150,000 to 250,000 k. w.

Considerable study has been made of the most economical transmission voltage for interconnection purposes and a recent paper presented to the American Institute of Electrical Engineers brought out the fact that 220,000 volts would be the most feasible and economical and such a system could be constructed without any material change in the design of present transmission line material. The highest transmission voltage in use at present is 150,000 and serves a 240-mile transmission system in California. This line is capable of transmitting approximately 57,000 k. w. with a line loss of 11 per cent. Studies of this line have indicated that it would be feasible to increase the voltage to 220,000 at a relatively small expense. By the increasing of the voltage to 220,000 there can be transmitted 125,000 k. w. with the same line loss above indicated.

Progress and Projects

California has taken the lead in the interconnection of their existing power plants and in utilizing to a very great extent the potential water power resources. In the southeastern portion of the United States considerable development has also been made along this line. A comprehensive scheme for the Northwestern states has been worked out for the erection of huge stations and interconnecting them. The territory served by the proposed project is from Pennsylvania north to Maine and takes into consideration the utilization of all of the existing water power resources in that section and the construction of large steam stations. The Central States are sadly deficient in the economic production of power, as this particular section has a large number of small and isolated stations operating independently.

Advantages of Interconnection

The advantages of interconnection of plants scattered throughout a large territory are apparent. In the first place, the diversity factor is considerably improved by such interconnection. Plants in the different territories serve different kinds of loads and consequently there are certain periods of the day and night that these plants in each territory are considerably under-loaded. By the interconnection of these plants, the hours of peak load of one plant would be the hours of a very low load of another plant, and the two plants operating together would be able to operate at or near their normal rating at a considerable saving in fuel and in the installation of generating equipment. Furthermore, the interconnection of a number of plants insures greater reliability of service. The problem that will come before the engineering profession within a few years will be the construction

of these super-stations at the centers of our fuel reservoirs and the construction of high-tension transmission lines. These super-stations will be scattered throughout the entire country and interconnected by groups or districts. It has been predicted that some day in the distant future we may see an interconnected transmission system extending from Maine to California and from the Great Lakes to the Gulf, all served jointly by a number of plants of large capacity.

Super-Stations in Project

The average small central station of 500-k. w. capacity and less has an efficiency from the coal pile to the switchboard of less than 5 percent. The efficiency of these super-stations will probably average 20 per cent. In fact, the large central stations of today show an efficiency of around 40 per cent, and considerable improvements are being made every day. This indicates that there is considerable room for fuel conservation by the installation of these super-stations. By the construction of the proper transmission lines transmitting large blocks of power, the loss of transmitted energy will average 10 per cent. From studies made of the interconnection problem, the 220,000-volt transmission system appears to be the probable ultimate plan. In the installation of lines of extremely high voltage, there are several factors to be taken into consideration which determine the most economical voltage. The corona loss and charging current of the line are very important factors entering into the operation of high voltage lines and limit the maximum voltage for a given block of power to be transmitted. Studies of this problem indicate that at 220,000 volts the probable block of power to be transmitted per circuit is around 125,000 k.w. In developments of this character reliability of service is of course essential and duplicate lines should therefore be installed, either by parallel lines or by ring or loop system. As the power requirements of the district increase beyond the capacity of the lines, it will of course be feasible to construct additional lines.

Increase in Manufacturing

The number of manufacturing establishments in this country is increasing quite rapidly and it will be necessary to make provision for future increases. In 1914 there were approximately 275,000 manufacturing establishments in the United States. This refers to plants of every nature manufacturing products in excess of $500 per year. The total power represented by the above establishments was 24 million horse power and of the above amount approximately 8 million horse power was in electric motors. This is increasing to a great extent. In fact, during the 5-year period from 1909 to 1914 the capacity of electric motors installed in these plants increased 80 per cent. Motor drive is well recognized as the most economical form of power and the leading industries of the country are realizing this more and more every day and are changing their form of power to electric drive. Therefore, it is necessary that the central station industry take cognizance of this fact and make preparations to take care of the increasing demand that will be made upon it.

Central Plants at Fuel Centers

We will see in the very near future a network of transmission lines emanating from large central stations and extending to all market centers and the small town and the farmer will be able to utilize this efficient form of power at greatly reduced cost. Plans are under way in Oklahoma at present for the construction of two large central stations at the fuel centers and it is very likely that additional super-stations will be constructed in the districts favored by natural fuel resources and the transmission lines extended to other parts of the state not favored by fuels. As all know, the western portion of Oklahoma is considerably handicapped by lack of fuel resources and the extremely high price of fuel in that section, and when such time comes that the high-powered transmission line serves this particular section, it will be able to have its own manufacturing industries.

In conclusion it may be stated that from present indications there will be constructed in the very near future super-stations of from 150,000 to 250,000 k.w. capacity, interconnected by 220,000 transmission lines and territories that are now badly in need of cheap power will be able to benefit by same.

The foregoing article is the major portion of a paper presented by Mr. Mullergren before the latest annual convention of the Oklahoma Society of Engineers.

Contracts Awarded

ROADS AND STREETS

Ala., Bessemer—J. E. Moran Paving Co., awarded contr. for 66,300 sq. yds. Warrenite-Bitulithic pavement on 5-in. cement concrete foundation.

Ariz., Florence—Maurice Ryan, Francos Aparts., 10th and Broadway, San Diego, awarded contract for constructing Sec. D, Florence-Superior Hwy., F. A. Proj. 23, at $134,111.

Cal., El Centro—Peterson, Dillon & Patterson (H. H. Peterson, Calexico and H. E. Dillon, 3788 S. Vermont Ave., Los Angeles), awarded contract for paving with concrete 28½ mi. Imperial Co. Hwy., at approx. $774,090. Contr. includes 3 sects. of road—Imperial to Coltville, Brawley to Calipatria and El Centro to Calexico. Grading is being done by county.

Cal., Los Angeles—Rogers Bros. Co. 350 Merrick St., awarded contr. for paving 5.1 miles Alameda St. (Harbor Trk. Blvd.), from Slauson Ave. to Burton Ave., with 8-in. rein. conc. and disintegrated granite shoulders, at $271,946.

Cal., Los Angeles—Geo. H. Oswald, 366 E. 58th St., awarded contract for impvt. of Western Ave., Santa Barbara to Slauson Ave., at $184,904.

Cal., San Diego—Southwest Paving Co., 601 Cit. Nat. Bk. Bldg., Los Angeles, award. contract for paving 5.6 miles San Luis Rey Co. Rd., No. 2. Oceanside to Guaiome, at $152,333.

Cal., Santa Cruz—Bates & Borland, Oakland Savings Bk. Bldg., Oakland, awarded contract for constructing 4.7 miles of road between Santa Cruz and Boulder Crk., at $150,078.

Colo., Colorado Springs—Harold Shuck, Denver, awarded contract for about 3 miles of paving on the Broadmoor stretch from city limits on Nevada Ave. to Broadmoor Hotel, at $126,565.

Ida., Boise—S. E. Cumerford, low bidder on North and South Hwy. proj., Washington Co., at $179,870. Funds available $194,940. Contr. will be let pending approval of Co. Commrs.; J. C. Maguire, low bidder on F. A. Proj. 21, Roosevelt Hwy., Bonneville Co. Funds available $194,676; contractor's bid $243,771. Work will be carried on as far as available funds will permit; Fred Coolidge awarded contr. for construction of 19.2 miles of rd. in Power Co. on Idaho-Pacific hwy., at $108,583, also concrete for Butte Co. project on Idaho Central Hwy. Funds in amt. of $90,000 available for this work.

Kans., Oswego—Watts & Strafford, Concordia, Kans., awarded contr. by Council for 21,000 sq. yds. asph. conc. pavement, at $100,125.

Ky., Barbourville—Davy & Grahams, Pineville, Ky., awarded contr. to grade and drain 11.4 miles of road in Knox Co., at $365,916.

Ky., Dixon—J. L. Towsen, Clay, Ky., awarded contract to grade and drain 11.4 miles Dixon-Madisonville and Henderson roads, Webster Co., at $276,395.

La., Vidalia—Junkin & Gregory awarded contract to constr. 12 mi. gravel rd., Vidalia to Deer Park, at $100,000.

La., Vidalia—Junkins Bros. & Gregory awarded contract to constr. 12 mile road, at $120,000.

Me., Augusta—Following contracts let by State Hwy. Comn.: Paving 3.92 mi. State Rd. bitum. macadam, Westbrook, to A. D. Bridges Sons Co., Inc., Hazardville, Conn., at $92,739; Hassam Paving Co., 17 Federal St., Worcester, Mass., contr. for paving 1.57 mi. State Rd. concrete, Oxford and Norway, at $133,183; graveling 3.31 mi. State Hwy. Houlton, to Greenwood Constr. Co., Skowhegan, at $61,857; 3.6 mi. State Rd., Island Falls and Dyer Brook, to M. Hughes, Bangor, at $70,481; bldg. 2:25 miles conc. road from Norway to Paris Twp., to J. H. Kerr, Rumford, at about $75,000.

Mich., Detroit—Jno. A. Mercier awarded contr. for rd.-bed to be constructed on Charlevoix-Buchanan section of Municipal Ry., at $605,531.

Mich., Lansing—J. A. McKay & Son, De-

troit, awarded contract for grading, draining and surfacing 8.046 mi. Assessment Dist. Rd. 205, 16 ft. wide, St. Clair and Macomb Cos., at $119,388.

Minn., Aitkin—B. Olson, Aitkin, awarded contract for grading and graveling 10 miles F. A. Proj. 86,. St. Rd. 3, at about $106,000.

Minn., Walker—P. W. Roark, Thf. River Falls, awarded contract for 12.66 miles Job 2004, and also 12.6 mi. F. A. Proj. 140, State Rd. 11, at $93,787 and $43,700 respectively; 7.59 mi. F. A. Proj. 142, State Rd. 6, to L. & L. Constr. Co., Walker, at $57,089; Wilkinson & Pettijohn, Walker, contr. for grading and graveling 7.5 miles Job 2001, at $44,558.

Mont., Helena—B. P. Melchert, Lewistown, awarded contract for proj. 48, Fed. Hwy.—25 miles rdway betw. Baker and Ekalaka, Fallon Co., at $72,076; J. E. Hilton awarded contr. for No. 86—17 miles and brdg. Fallon Co., on Yellowstone Trail, at $110,646; Albert Carlson, contract for proj. 129, for 1.16 miles on Pershing Crk. Hill in Stillwater Co., at $26,823.

N. J., East Orange—Standard Bitulithic Co. awarded contr. for 19,000 sq. yds. Warrenite-Bitulithic pavement resurfacing Old Telford.

N. J., Newark—Northern Constr. Co. and Marcellus & Osborne awarded contracts for about 58,800 sq. yds. Bitoslag pavement in Belleville and Nutley, N. J. Total cost of contracts, $275,000.

N. J., Trenton—State Hwy. Comn. let contract for paving 22,910 sq. yds. St. Hwy. 1, Milton Ave., Rahway to Rahway-Linden line, bitum. concrete, to M. I. Demarset, Sewaren, at $204,485; 22,382 sq. yds. Sec. 10, Rahway-Linden line to Roselle Boro., bitum. conc., to C. H. Winans, 207 Broad St., Elizabeth, at $214,296; 27,007 sq. yds. Sec. 11, Roselle Boro., to Elizabeth city line, bitum. concrete, to J. Dorer, Irvington, at $237,489.

N. J., Trenton—Weldon Constr. Co., Westfield, awarded contract for paving 9 miles hwy. at Rahway, Union Co., at $115,-850.

N. J., West Orange—Franklin Constr. Co., 52 Vanderbilt Ave., New York City, awarded contr. for impvt. of Mt. Pleasant Ave. here, at $116,700.

N. M., Santa Fe—A. T. Young, Denver, Colo., awarded contract for construction of N. M. Fed. Aid Proj. 34-B, Rio Arriba Co., which includes approx. 12 miles grading and surfacing; also draing. structs. located betw. Chama and Tierra Amarilla, at $95,-991, exclusive of 10% for engineering and contingencies.

N. Y., Long Island City—City let contr. for paving Ash St. to Kennedy & Smith, 94 Main St., Flushing, at $7,898; Broadway, to the Sicilian Asph. Paving Co., 41 Park Row, New York City, at $225,590; Metropolitan Ave., to Welsh Bros., 14 Queens St., Astoria, $13,135; 97th St., to Hastings Paving Co., 25 Broad St., New York City, at $97,680; 97th St., to Cleveland-Trinidad Paving Co., 3409 Kimbull St., Cleveland, at $66,055; Opdyke St., to Pease Bros., 38 Park Row, New York City, at $4,075; Stockholm St., to Union Paving Co., Broadway and 112th St., New York City, at $8,412; crosswalks from Woodside to Stryker Aves., to C. Kurth, $6,576; Grandview Ave., to C. A. Myers, Stagg St., Brooklyn, $10,655.

N. Y., New York—W. J. Fitzgerald, 547 W. 45th St., awarded contract for regulating and repaving W. 54th St., sheet asphlt.; also Hudson St., wood block, at $42,758 and $109,131, respectively.

N. C., Carthage—J. T. Plott, Greensboro, N. C., awarded contract to construct 21 miles gravel road in Moore Co., at $150,-000.

N. C., Warrenton—Chandler & Ragland, Virgilina, Va., awarded contr. to construct 19.76 miles clay-gravel road from Warrenton, in Warren Co., at $160,000.

Ohio, Cleveland Heights (Warrensville, P. O.)—Spence Bros., Woodhill Rd., Cleveland, awarded contracts by Village for grading, draining, curbing and paving with asph. Wood Rd.—Crest Rd. to Crest Dr.—Maple Rd.—Mayfield to Wood Rd.; Glenwood Ave.—Cleveland Heights Blvd. to Noble Road, at $45,862, $62,086 and $28,910, respectively.

Ohio, Cleveland Heights (Warrensville, P. O.)—Village let contracts to Cleveland Trinidad Paving Co., The Arcade, Cleveland, for grading, draining, curbing and paving Kensington Rd., at $46,756; Kerrwood Rd., $9,773; Maplewood Ave., $19,949; Oakdale Rd., $19,969; Princeton Rd., $45,-903; Taylor Rd., $47,500; Briarwood Rd., $19,965; Canterbury Rd., $46,385; Colchester Rd., $13,610; Cottagegrove Rd., $19,969; E. Derbyshire Rd., $30,449; Edgewood Rd., $15,231.

Okla., Tulsa—Tibbets & Pleasant awarded contract to pave Riverside Drive addn., $250,000.

Pa., Harrisburg—Contracts for St. Rd. awarded as follows: Delaware Co. Upper Darby Twp. and Milburn Boro., 2,635 ft., to C. E. Wood, Inc., Albany, N. Y., at $36,-084; Northampton Co., Bangor Boro., 7,441 ft., to C. E. Weed, at $110,673; Westmoreland Co., Derry Twp., 13,625 ft., to M. Bennett & Son, Indiana, at $190,931.

S. C., Columbia—Bitulithic Company awarded contract for paving N. Main St., approx. 7 blocks, at $104,824.

S. C., Columbia—Powell Paving & Contg. Co. awarded contract by Richland Co. Hwy. Comn. to construct 15.2 miles Two Notch Rd., 43,265 cu. yds. sand-clay surfacing, at $137,000.

S. D., Aberdeen—St. Hwy. Comn. let contract for grading and draining 21.1 mi. Yellowstone Trail from James west through Aberdeen to west county line, F. A. Proj. 42, Brown Co., to H. C. Hansen, Groton, at $114,696; 10.7 miles Yellowstone Trail—Summit to W. Co. line, F. A. Proj. 44, Roberts Co., also 16.5 mi. rd. west and so. of Leola, F. A. Proj. 63, McPherson Co., to Stevens Bros., St. Paul, Minn., at $74,450 and $91,436, respectively.

Tenn., Memphis—Crinkley Constr. Co., Harriman, Tenn., awarded contrs. for constructing three streets in city (29,545 sq. yds. sheet asph. pavement), at approx. $152,000.

Tex., Cleburne—O'Connor & Gilkison, Dallas, Tex.; also Williams, Burk & Co., Jacksonville, Tex., awarded contracts to construct 16 mi. Lone Willow and Rio Cista Rds., Precinct 1, at $97,000.

Tex., Hillsboro—Bibbs & Hughes, Waco, Tex., awarded contract to construct 75 mi. of road in Abbott, Acquilla, Mt. Calm, Bynum and Hubbard Dists.; $700,000.

Tex., Texarkana—Taylor & Hamilton, Chicago, Ill., awarded contract to pave 60,-000 sq. yds. streets; $300,000 available.

Wn., Colfax—Highway Constr. Co., Colfax, awarded contracts for road bldg. as follows: Impvt. No. 7, from Seltice to Farmington and impvt. No. 8 from Tekoa to near Seltice; crushed rock macadam, at $123,836 and $70,904, respectively.

Wn., Seattle—Jahn & Bressi awarded contract for paving W. 56th St., at $113,-102; S. A. Moceri, contract for paving 17th Ave., et al., at $116,003.

W. Va., Beckley—Sutton Constr. Co., Pikesville, Ky., awarded contr. to construct 4¼ miles Jarrold's Valley Colcord Rd., Marsh Fork Dist., at $115,379.

W. Va., Charleston—Randish Constr. Co., Princeton, awarded contr. to build 4 mi. road from Paint Crk. Jct. to Livingston Sec. 8, at $64,000; 7.1 mi. rd. from Cabin Crk. Jct. to Loudon Dist., Sects. 5 and 6, to Towles & Co., Princeton, at $179,530; 3 mi. rd. from Montgomery west, Sec. 4, to Abbott Bros., Charleston, at $27,470.

W. Va., Fayetteville—J. M. Randish Constr. Co., awarded contr. to grade 9½ mi. road on Lower Loup Crk. from Robson to Ingram Branch, at $134,000.

W. Va., Webster Springs—H. H. Bruffey awarded contract to grade road and constr. culverts; $6,000 yds. excav., $100,-000 available.

SEWERAGE AND SEWAGE TREATMENT

Ariz., Miami—Wm. D. Walsh, 1235 Dewey Ave., Los Angeles, awarded contract for constr. of Sec. 1, Miami Sewer System. Contr. awarded on cement pipe and amounts to about $113,300.

Ill., East St. Louis—J. Keeley Constr. Co. Cahokia Bldg., awarded contract for bldg. 7 miles 48-78 in. rein. conc. and 20-48 in. vitr. sewer pipe in Winstonly Sewer Dist., at about $415,000.

Ind., Muncie—C. C. Harris, Youngstown, awarded contract for constr. of Southside sewer, at $355,000.

Mass., Boston—Jas. Barletta awarded contract for sewerage works in Saville St. and Wren St., betw. Park St. and Oriole St. and Bd. of Survey St. 664, betw. Wren and Emmons Road, W. Roxbury, at $40,-961.

Mass., Boston—D. Vitiello award. contr. for sewerage work at River St., at $4,261; V. Grande award. contr. for bldg. sewerage works, catch basins, manholes, minor drains and surf. drains in Boston at $7,700; Louis Martinello contr. for sewerage wks. in Larch St., Brayton Rd., S. Crescent circuit, private land, Brighton, at $18,950; F. Drinkwater contr. for sewerage works in South St., Lesher St. and private land, Archdale Rd., West Roxbury, at $21,945.

Mass., West Springfield (Springfield, P. O.)—C. D. Farnsworth Co., 16 Union St., awarded contract for bldg. sewerage system in So. Union and Palmer streets, at about $51,000.

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EDITORIALS

ON PAPER OR ON THE GROUND?

An unprecedented mileage of hard roads will be built in this country during 1921, but whether the record will be made on the ground or only on paper remains to be seen. As we are interested, in common with all others presumably, in seeing the roads actually constructed, let us face squarely one cause which again bids fair to contribute to a paper record only. We refer to the open-top car problem, and it is a problem of prime importance.

First of all let us stop weeping with the railways over their real and fancied misfortunes. They seem to have achieved their ends with respect to rates. Let us admire their political cleverness but let us demand service. From what we have seen of railway operation and from what we have heard of the amenities of the construction camp we will hazard the opinion that a judicious application of construction camp profanity to railway operatives will amazingly speed up the movement of open-top cars. Railway men from president down to back flagmen should be made to realize keenly that it is time for them to stop blubbering. It is up to them to deliver now. That rail-transportation has improved recently is gratefully acknowledged and should be accepted as evidence that greater improvement is possible.

But while reasoning with the railway interests in the manner described let us also better order affairs in the highway field. Road construction contracts should be awarded as soon as possible and successful contractors should, so far as possible, transport road building materials during the winter months and store them where they will be much wanted when construction opens up in the spring. This will relieve transportation congestion. By using open-top equipment for construction materials during the season when harvest, ore and coal movements are not at their maximum the general transportation situation will be benefitted greatly.

Contractors who have material available for use next spring as soon as weather conditions permit construction work will be spared the expense incident to the usual rail congestion and car shortage. It is thought that the resulting economies in highway production will much more than offset the interest on the investment in materials. In road building, as in any kind of manufacturing, it pays to have materials on hand when wanted in the production schedule. Certainly it is very expensive to shut down a road building plant frequently while waiting for materials.

In some states money may be advanced to the contractor for material on hand; elsewhere material on hand will facilitate securing bank credit.

It is hoped that state highway departments and road contractors will do all possible this winter in providing construction materials for early use next spring. Much can be accomplished in a spirit of forehanded cooperation.

A PLEASANT INCIDENT

Very often we have endeavored to convince an engineer that his work is of interest to the public and to his profession. While some engineers appreciate this truth, others, perhaps the majority, do not. There is no question of sincerity involved, of course, as it is the honest belief of the average engineer that his work is devoid of news value. We do not concur in this belief for its fallacy has been demonstrated many times. A recent incident serves to illustrate the point we have attempted to establish.

Not long ago we received an unsolicited contribution from a county engineer with whom we had not been in correspondence at all. In submitting his brief article he stated that he was doing so in line with a suggestion he had received from an acquaintance. The article was offered as a contribution without thought of direct compensation and with the statement that if considered unavailable it need not be returned. Two pictures accompanied the manuscript.

This contribution, so generously and so modestly submitted, was considered worthy of publication in this journal, and it appeared in a recent number. As soon as that issue was out a telegram was received from a very prominent national, weekly magazine, asking permission to reprint the article and requesting the use of the original photographs. Of course, it was a distinct pleasure to grant this permission and to forward the photographs. As soon thereafter as possible quotations from the article, attractively illustrated, appeared in the national magazine and the modest circulation given by this journal to the original article was increased by hundreds of thousands by the publication of the quotations. Full credit was given the author by the popular magazine. His story and the pictures were considered of sufficient popular interest to make the top of a right-hand page near the front of the widely-read weekly.

While such incidents have occurred before we derived very great pleasure from this case because of the modest manner in which the original article was brought to our attention. We hope this brief review of the circumstances will persuade other engineers to write of their work, which is probably of more interest to the public than they realize.

THE CHICAGO DRAINAGE CANAL: TODAY AND TOMORROW

By Francis C. Shenehon, Mem. Am. Soc. C. E., Mem. Am. Inst. of Consulting Engineers, Consulting Hydraulic Engineer, 628 Metropolitan Bank Bldg., Minneapolis, Minn.

The recent decision of Judge Landis of the Federal Court making permanent the injunction limiting Chicago from taking more water from Lake Michigan than is fixed in the permit of the Secretary of War marks the end of a chapter in the most celebrated case involving hydraulic controversies ever decided.

The case is big in the conflicting elements; the navigable integrity of the world's most important inland waterway operated jointly by the United States and Canada on the one hand, and the interests of the great State of Illinois with its waterway project to the Mississippi, and the health and well-being of the second largest city of the land in the disposal of sewage and the protection of its water supply, on the other.

It should be immediately stated that it is unthinkable that the Federal Government will ever use its great power to menace the health and safety of the people of Chicago and the suburban communities comprised within the Sanitary District. The modification in the method for the continuance of pure drinking water and the avoidance of an evil-smelling canal and river must be accomplished over a period of some years. Chicago must eventually have a purer and clearer drinking water than now; and the Drainage Canal and the Illinois River must eventually be less offensive than they are at the present time. And the strong arm of the Federal Government will doubtless work with the strong arm of Illinois itself to bring about these most desirable things—and without permanent injury to the navigable capacity of the Great Lakes.

The writer has perhaps had unusual opportunities to view both sides of this controversy and look upon the equities of each party judicially and humanly. He was Advisory Expert Engineer for the United States on all the physical questions of a hydraulic nature, which resulted in a demonstration of the exact amount in inches by which the channels of the lakes would be shallower by reason of the new outflow canal at Chicago. Then after the court case was closed, the Sanitary District retained him as hydraulic engineer to design regulating works to restore the impaired channel depths by throttling the outflow rivers, Niagara and St. Lawrence. During the progress of the litigation the relations between the lawyers and expert engineers of the two sides were always cordial. It was really a friendly suit to decide whether the State of Illinois, through its police power to safeguard the health of its people, could use such methods as would injure the navigable capacity of the interstate and international navigable channels of the Great Lakes—of which the Federal Government is guardian. And the comity and good feeling which should mark the relation between a single sovereign state and the constellation of all the states always prevailed. It was not remarkable therefore that the expert of the United States during the litigation should become the expert of the Sanitary District afterwards, with the acquiescence of the former.

It is assumed that the readers of a journal published in Chicago are familiar with the physical features of the Drainage Canal. It is a great canal cutting across the low divide, separating the south end of Lake Michigan from the headwaters of the Des Plaines River—which is a tributary of the Illinois River which in turn leads to the Mississippi River and the Gulf of Mexico. This low divide marks an old outflow channel by which Lake Michigan drained to the Gulf in some prehistoric geological epoch. The drainage canal water is therefore in a way the return of a son much more prodigal earlier than now. The capacity of this great Drainage Canal, as now cut through the rock divide, is about 14,000 cu. ft. per second, which is about four times the volume of normal flow of the Mississippi River at Minneapolis, the water power city of Minnesota.

The Chicago River, which in the earlier days constituted a little harbor and was the focus about which the city grew, is reversed now, and instead of pouring a sewage-polluted stream into Lake Michigan, serves to suck in from the lake a stream which has the effect of always directing clean, decent water against the city shore-line, and keeping the intakes of the water supply of Chicago almost always in the current coming from the deep mid-lake storage. Branch canals reach up towards Evanston and Calumet.

The Sanitary District of Chicago comprises not alone the city, but the suburban communities as well. The district is a child of the state and amenable to state laws. One of the laws which the trustees have felt compelled to obey is the prescribed dilution of the sewage. This is based on the population of the district and must be 3 1/3 cu. ft. per second for each thousand people. This means over two thousand gallons a day for each individual of population—but the industrial wastes, the stock yards contribution of filth and street washings, reduce the strict per capita relation. The amount of water already in use as a diversion from Lake Michigan approaches 9,000 cu. ft. per second. The present Federal permit is 4,167 cu. ft. per second. The trustees, between the devil and the deep sea of Federal Law and State law, obey the State law.

It may be illuminating to review briefly the circumstances, out of which Chicago's outlawry grew and mention some mitigating circumstances. It should always be understood that in thinking of the Sanitary District we must think of the people comprised within it as the multiple proprietors, and not the trustees who serve the people briefly and in succession as their representatives. If in the past any trustee may have existed whose attitude was arbitrary or short-sighted, that must be forgotten; and the thing to be remembered is that nearly three million people now have a problem on their hands to be solved as of today and tomorrow without any reprisals for yesterday.

At the time (1889) of the inception of the Drainage Canal as the best solution of Chicago's water-supply and sewage disposals problems—conditions were very different from the conditions today in many respects. Sewage disposal as an art was not far advanced—the digestion of crude sewage by the action of running water was the prevailing method. This digestion is still regarded as a proper use of the potentialities of streams. The navigation of the Great Lakes was

comparatively small, with the vessels themselves drawing only 13 or 14 feet of water. The hydraulics of the outflow streams had not been developed and the lowering effect to come with the diversion at Chicago was more or less an academic bug-bear. Water power at Niagara was in its infancy and the water used there was used wastefully. The plant begun at Niagara in 1890, was designed to take only half the energy out of the water used. Water economy was not considered necessary.

So Chicago just started in to take this great volume of water out of Lake Michigan, without any definite arrangement with the United States to do so. With the characteristic optimism of the booming metropolis of the West—millions upon millions of dollars were poured into the great enterprise. The officers of the United States knew about it and did not stop it. It just went on with the confident assurance that the water would be forthcoming when opening day came.

Now, it is rather odd that other great enterprises in the Great Lakes system did much as Chicago did—were initiated and operated under State Charters, even when they affected injuriously the navigable waters of the United States and Canada. The water power enterprise at Niagara Falls—the tunnel project—was built, and operated for a number of years on State Charter without Federal permit; and 8,600 cu. ft. of water per second were diverted. This slightly lowered the Niagara River, and injured very insignificant navigable channels —but the principle was the same as at Chicago. The one great difference between the Chicago diversion and others is that others return the water to the Great Lakes system —while Chicago abstracts it for good.

Well, Chicago should, back in 1889, have secured Congressional sanction for the 10,000 cu. second-feet of water she expected to take out of Lake Michigan—but she did not do this. And as time went on and the various Secretaries of War did not feel warranted in issuing permits for more water than 4,167 cu. ft. per second, partially because the injury to navigation was international in its effect on Canadian channels and partially because the question was too big for an official determination, some of the Sanitary District trustees became defiant and openly stated that they would take all the water that they could get through the canal—14,000 cu. ft. per second or more—despite the restrictions of the Federal Government. Of course this attitude created very bad feelings between the District and the War Department. It should be noted that the attitudes of Secretary of War Taft, and later Stimson were very fair. They simply said that the hurtful effect on the Great Lakes was so pronounced that it became a matter for Congress to settle.

It is certain that the position of the United States is sound and fair. The diversion of 10,000 cu. ft. of water per second at Chicago will lessen the cargo carrying capacity of each of the big vessels about 400 tons on each trip. This is a substantial damage. The loss in water power at Niagara approximates 300,000 electric horse power; and on the St. Lawrence perhaps 200,000 electric horse power. Very little of this loss is made up as the water goes towards the Mississippi River. This power loss means not so much at the present time as it will twenty-five or fifty years from now. It is quite clear from these statements of damage why no officer of the United States wished to assume the power to permit these great national and international injuries and losses—and that each referred the matter to Congress. It appears now that Congress will grant Chicago the right to divert 10,000 cu. ft. per second—enough to care for the sewage dilution of a 3,000,000 population—but no more; and that this permit should be conditioned on Chicago's furnishing the funds—two and a quarter million dollars—to build regulating works on the Niagara and St. Lawrence Rivers—as designed by the writer—to restore the impaired channel depths; and further conditioned on Chicago's adoption of a definite program of artificial sewage treatment to lessen the nuisance in the canal itself and in the Illinois River as the population increases.

It is now definitely accepted that in the Treaty of 1909 with Great Britain, certain divisions of the water of the Great Lakes were agreed upon, which took into account, but did not authorize, a diversion of 10,000 cu. ft. per second at Chicago. Congress may therefore now act without the embarrassment of international complication which appeared inevitable before this fact concerning the treaty was clearly apprehended.

This article would not be complete without stating that legal steps are contemplated by the District—looking to a modification of the injunction of Judge Landis—and that the court may assume the responsibility which the War Secretaries have felt should be borne by Congress. The case will doubtless be appealed to the Supreme Court of the United States.

PRESENT STATUS OF MACADAM BASE FOR BITUMINOUS PAVEMENTS

By Julius Adler, Technical Engineer, Atlantic Refining Co., 1211 Chestnut St., Philadelphia, Pa.

There has recently been a marked revival of discussion devoted either partly or exclusively to the value of macadam and bituminous concrete as foundations for use under asphalt pavements of various types. While the two kinds of base mentioned have some points of similarity, there are essential points of difference, and what follows has reference only to macadam and closely related types. An analysis of these discussions shows the following advantages claimed for this type of construction:

Advantages of Macadam Base

1. Economy in utilizing existing macadam pavements.
2. Lower cost (depending upon available materials, labor, rates, etc.) of construction of new macadam base as compared to Portland cement concrete.
3. Freedom from the transverse cracks which develop in bituminous surfaces on Portland cement concrete, due to the contraction and cracking of that type of base.
4. Slight "resiliency" of the macadam base, which reduces the hammering or anvil effect produced upon an asphalt surface laid on an unyielding base.

A considerable number of the statments above referred to have issued from disinterested sources and the following quotation from an article by a City Engineer of a Southern town is fairly typical of the viewpoint of those advocating the use of macadam and similar foundations, either old or newly constructed:

Why One City Engineer Abandoned Concrete Base

"From long experience and observation of the behavior

of bituminous pavements laid both over a concrete base and over a well constructed macadam base, this department has concluded to abandon the use of the concrete base for bitulithic and other types of bituminous pavements. The reason for this conclusion is that bitulithic actually stays put on a macadam base very much better than on concrete. A properly prepared macadam foundation is quite elastic. It absorbs a considerable portion of the shock of heavy auto trucks and does not throw the entire burden of impact upon the wearing surface. Use is made of the old macadam roadway surface to the fullest practical extent. The grades and crowns for the new pavement are adjusted so as to disturb the old macadam roadway bed as little as possible."

Numerous quotations similar to this could be drawn from both printed and verbal discussions by engineers to illustrate the same point, and examples too numerous to mention are cited of the successful use of bituminous pavements on this type of base from Southern Canada to Florida.

Use of Macadam Road as a Base

In contrast to this viewpoint is the growing tendency in some localities to disregard the possible value of the macadam road for use as a base, the explanation usually being that it is inadequate under all year round heavy motor truck traffic. In such localities the macadam road is perhaps, without exaggeration, regarded as a sort of necessary evil, the best examples to be maintained by bituminous surface treatments until conditions permit of removal and complete replacement by a new type of construction, while those less acceptable are replaced as speedily as conditions permit. In support of this position are the reports from a number of localities of serious damage to both macadam roads proper and macadam base types during the winter of 1919-20.

Between these two opposite and extreme viewpoints there must undoubtedly be a proper course of action dependent upon a number of conditions and taking into consideration both immediate and ultimate economy in expenditures. Obviously, with the great extent of territory in which macadam roads may be found, with the wide variation in climatic conditions, and in volume and weight of traffic (both of the latter frequently occurring within a comparatively limited area), broad statements in regard either to the merit or lack of merit of a given type of pavement should be made with caution, since they may too often be based upon strictly local examples of construction whose success or failure may have been attributable to strictly local conditions.

Factors Affecting Strength and Durability

The solution of the problem of determining the limitations of a given type of paving construction lies in first establishing the factor affecting its strength and durability, and second the application of these factors to a specific case of proposed construction—the latter, it must be admitted, being very often a difficult matter.

In the present case these factors are as follows:

I—Strength of the base.

II—Variation in supporting power of the earth subgrade.

III—Volume and weight of traffic.

Strength of Base

Under this heading is included such elements as (a) total depth and degree of consolidation of the base, (b) the size of the units used as aggregate, and (c) the strength and durability of the aggregate.

In the matter of depth of base, it is of course generally recognized that other things being equal the greater the depth the greater the area to which a given load is transmitted.

Degree of consolidation, as an item under Strength of Base, refers to the thoroughness with which the pieces of aggregate have been pounded into place during the process of construction and especially by the action of traffic. In this connection it is generally conceded that macadam which has actually carried traffic, if only for a comparatively short period of time, is more reliable from the standpoint of consolidation than that which has been compressed only by means of a roller.

Under size of units of aggregate there must be considered the relative value of a base consisting of small pieces of stone, say 1½ in. in diameter and less, or one consisting chiefly of coarse or ballast-sized stone, and finally of a base in which large pieces are employed such as the Telford type, or the stone "sub-base" frequently used in New England, New York and elsewhere.

Results in general point very clearly to the greater value of the base employing the largest possible size of aggregate, affording as it does greater stability and better distribution of loads, freer drainage and less disturbance by frost action.

Under strength and durability of the aggregate is considered the quality of the material composing the aggregate itself. Exetremely soft, shaley or rotten stone and very porous grades of sandstone and similar materials will, in course of time, disintegrate under combined traffic and frost action. In general, however, it is pretty well established that no such degrees of hardness and toughness are required for the base material as for the aggregate composing the wearing surface.

Variation in Supporting Power of the Earth Sub-Grade

Observation of failures of macadam foundations shows that in the last analysis this factor is usually the one causing the most serious damage. The supporting power of the sub-grade is evidently affected primarily by the character of the soil, by the natural and artificial provisions for drainage and by climatic conditions, including the amount of rain and snow-fall, depth of frost action and likelihood of alternate freezing and thawing.

In past years when the well-built macadam road might have been called the most approved type for all but city use, examples of its surprising beam strength, with subgrade support removed, were frequently discovered. For present day traffic conditions, however, wherever motor trucks are using the roads, the beam strength of the usual macadam base must be considered as nearly negligible; in other words, there must be reasonable assurance of nearly uniform sub-grade support for any except possibly foundations made up of a considerable depth of large or Telford size stone.

The character of the soil is clearly all-important in this connection. Free draining, sandy and gravelly soils form, as is generally understood, vastly better sub-grade than retentive clay soil, and in certain localities there are astonishing examples of extremely light macadam bases laid on free-draining sub-grade of the sort referred to, and carrying considerable traffic with entire success.

Where the location of the road and character of the soil are such that natural drainage is poor, all forms of artificial drainage should be provided. Every discussion on proper road construction has from time immemorial included a statement in regard to the prime necessity of good drainage, while at the same time conceding that it is a sadly neglected feature. Whatever may have been the necessity for proper drainage under the traffic of the past, it was never half so essential as it is under the heavy loads of today. That considerable improvement in the uniformity of supporting power of the sub-grade can be effected through provision for artificial drainage, is definitely established, and in many cases a macadam base now giving unsatisfactory service can be made entirely satisfactory. This will undoubtedly leave a small percentage of extreme cases where poorly drained heavy clay soil conditions in flat sections subject to severe frost action will represent a combination of circumstances under which the average macadam base will have insufficient strength under heavy traffic units, even though the prevailing methods of sub-drainage are provided. Such conditions, however, are likely to prove a severe test of the strength of any type of base of ordinary strength or thickness.

Alternate freezing and thawing resulting in the condition of soft, thawed outlayers overlying hard frozen ones, together with the usual heaving effects, etc., produce a very serious lack of uniformity of supporting power unless the sub-grade can be kept nearly dry throughout the winter.

In contrast with this condition there may be cited numerous examples of roads preserved in localities where after winter has once set in, the temperature remains uniformly low enough to keep the earth in a frozen condition, thus preserving its supporting strength, and eliminating the possibility of the percolation of water into the soil during this period. When this condition prevails, the critical time for the base is limited to the period during the spring, when the frost leaves the ground, and the danger of breaking up is consequently much reduced as compared to the road which is subjected to the possibility of several alternate freezing and thawing periods during a single winter.

VIEWS ILLUSTRATING THE USE OF MACADAM BASE FOR PAVEMENTS.

Top Row: Macadam Base with Clean, Slightly Rough Surface. (Consolidated Macadam, about 22 ft. Wide for 18-ft. Asphalt Pavement)—Binder Course (in Foreground) and Prepared Base. (Consolidated Macadam Extends Almost to Ditch Lines.)

Bottom Row: Asphalt on Macadam Base, with Wide Surface. Treated Macadam Wings. (A Desirable Combination, Giving Excellent Results on an Important Suburban Thoroughfare.)—Effect of Weak Shoulder. Lack of Support Permits Spreading of Pavement Under Heavy Truck Traffic.

Volume and Weight of Traffic

Traffic records over the past five to ten years, especially in thickly populated sections and near large cities, show enormous increases in the volume of traffic over trunk line highways. Accompanying this increase in volume of traffic has been the much more serious matter of increase in weight of the traffic unit, resulting in the use of many of our old roads by concentrated loads several times greater than the heaviest experienced in former years.

From the standpoint of the integrity of the macadam base, probably the most important point is that of the likelihood of the use of the road by the loads in question throughout the year. In rather cold, mountainous or

thinly populated sections where the traffic practically disappears through the winter, and does not reappear in quantity until well on into spring, at a period when the sub-grade is pretty well dried out, the damage by this type of traffic to the macadam foundation may be relatively slight, while in general the most severe damage is found in localities where the heavy motor truck uses the roads throughout the year, and more especially during the months of February, March and April.

Suggestions for Improvement

Assuming the foregoing outline to be a correct analysis of the elements which affect the supporting value of the macadam and similar types of foundation, the problem remains of applying these factors to an individual case, and attempting to determine in advance which ones would be likely to limit the life of the foundation and the overlying pavement.

Since each of these elements will vary with every individual case, only general suggestions and recommendations can be made to aid in their application.

In the matter of strength, it will be found that recent recommendations as to the minimum permissible depth of a base of this type vary from as low as 4 to as high as 12 ins., depending somewhat on individual opinion as well as upon the soil and drainage conditions, etc., affecting the given piece of work. In general there has been a decided tendency to overestimate the depth of existing bases, arising largely from the belief that the annual practice of "dumping stone" on the road over a period of years has resulted in building up a very considerable depth, and failing to take into consideration the fact that usually an equal amount was removed by traffic. This, of course, suggests that, in the use of old roads, a careful survey of the depth of the road should be made by means of test holes, giving an idea, not only of the depth, but also of the character of the existing aggregate. Examinations of this sort will show many old roads containing an average depth of 6 to 8 ins. (in some localities, much more) of compacted stone—these being the ones that are well worth saving.

In general, no radical view should be adopted as to the least thickness of base which will support the proposed pavement since there are few localities in the northeastern half of the country, and especially near large cities, where a total depth of base of 4 to 6 ins. (as sometimes recommended) will be sufficient. The writer believes, however, that even where an ample depth of stone is found, it is usually desirable on old roads to add a uniform layer of ballast-size aggregate which will serve to elevate the proposed bituminous pavement above the level of the old base which, due to the large amount of dust and fine material usually contained, is very likely to hold a considerable amount of moisture in its capillary voids at certain periods in the year. The objection usually offered to this is the danger of disturbance of the old consolidated road; and while in a general way this principle is undoubtedly correct, on the other hand the old road which will not stand disturbance for the depth of 2 or 3 ins. required for scarifying, before the addition of a new layer, will generally not be adequate in depth for use as a foundation in any case. Furthermore, the greater regularity of contour of the base to which a complete new layer of aggregate has been added, will be found to more than offset in the life of the bituminous pavement the original advantage of paving over a slightly better consolidated, but irregular base, which is likely to produce a pavement of irregular contour. Finally, consolidation can usually be completed by admitting traffic, under restriction, over the completed base.

In the matter of supporting power of sub-grade, a very considerable improvement over the existing conditions could be looked for from the adoption of the principle that in the utilization of existing macadam as a base for bituminous pavement, at least as much provision should be made for drainage as though an entirely new piece of road were to be built over the same character of sub-grade. This, however, is not generally done. Too frequently shallow ditches, ditches too close to the improved surface, sections requiring special drainage, etc., are likely to be allowed to remain without improvement. Recent reports from England are to the effect that macadam foundations under bituminous pavements are giving entirely satisfactory service, due to systematic attention to and improvement in drainage conditions.

One Type of Failure of Macadam Base

One type of failure of the macadam base has been the squeezing out and breaking up of the sides, due to combination of too little lateral support at the shoulders, the softening of the sub-grade under the edges of the pavement due to entrance of water, and, in general, failure to recognize that the sides of the road are frequently thinner and weaker than the central portion. As one means of overcoming this condition, it is believed that the thoroughly consolidated base of full depth should always extend at least 1½ to 2 ft. beyond the edge of the pavement laid upon it. If the improved surface is of reasonable and adequate width to accommodate traffic, it will then be found that the thrust on the foundation from heavy, slow-moving loads travelling on the sides of the road will meet with much greater resistance than is now encountered. If, however, the improved road is so narrow that heavy traffic is constantly cutting off and on, damage will naturally continue to result.

Waterproofing Shoulders

As a further step toward improvement, some means of waterproofing the shoulders, at the same time furnishing support at the edges of the bituminous pavement, should be provided. Cases have been noted where the existence of an old macadam shoulder even though rather thin, has been of material benefit. Well built stone block or rubble gutters and headers produce a similar result. If no better provision is to be made, all stone removed from the old surface should be used to harden the shoulders and additional aggregate brought in where required.

One of the best pratices in this connection on country roads consists in the construction of bituminous macadam wings three or more feet in width providing waterproofing and lateral support to the pavement, and at the same time furnishing a hardened surface capable of carrying occasional loads. At the least, however, there should be along each edge of the pavement a strip of hardened surface having the same width as the 1½ to 2-ft. extensions of the base previously referred to.

Width of Pavement

This recommendation may be criticized on the basis that it calls for the construction of a road of a greater width—with a consequent reduction in economy—than

would be required if some other type of construction were used, but in its support may be said that the change from an approved width of perhaps 15 ft. for two lines of traffic, only a few years ago, to the present situation where 20 ft. is frequently mentioned as being desirable, points unmistakably to the necessity for providing ample width at the outset on roads near large centers of population. It may further be added that there is reason for believing that many roads of other types built to widths of 16 and 18 ft. will eventually need protecting wings, not only for the accommodation of additional traffic, but the preservation of the pavement, as well, since at best a sudden drop-off from a hard surface to a soft earth or clay shoulder, is objectionable from several standpoints.

In a number of instances, the depth of the ditch and its distance from the edge of the improved surface appear to play an important part in the strength of the macadam foundation. If too close to the edge of the pavement, open ditches allow moisture to get under the base and reduce the support; if far away, leaving a wide unwaterproofed shoulder, there is too much opportunity for the entrance of water through the surface, especially at times when the ground is heavily blanketed with snow or ice. The absence of these pervious shoulders is noticeably beneficial in city and suburban streets paved from curb to curb. It is, therefore, believed that for country roads a shoulder about 5 or 6 ft. wide, with provisions for waterproofing between the edge of the road and a point near the edge of the ditch, represents the most desirable arrangement.

Summary

To summarize the foregoing discussion, it is believed that proper preliminary studies will make it possible to determine those cases where a macadam base for a bituminous pavement, would at best, be positively inadequate, and the steps which will be necessary in all other cases to place them in proper condition for use; that (in contrast to the old desire to make use of the macadam with as little expenditure as possible) greater attention to and provisions for proper drainage and thickness, admitting the present limitations to the knowledge of the matter of drainage, will still, in a large proportion of cases, establish the desirability and economy of utilizing existing macadam as a foundation for bituminous pavements.

The foregoing paper by Mr. Adler was presented at the recent annual convention of the American Society for Municipal Improvements.

RECENT EXPERIENCES WITH WOOD BLOCK PAVEMENTS

By Herman von Schrenk, of von Schrenk and Kammerer, Consulting Timber Engineers, Tower Grove and Flad Avenue, St. Louis, Mo.

During the past two years numerous failures of one kind and another have been experienced with wood block pavements. Following periods of heavy rain-fall during the summer of 1919 and at various times during 1920, wood blocks buckled and heaved and in some instances on long stretches of city streets the blocks floated away entirely. There has also been an increase in the number of cases of failure by decay of supposedly well treated blocks. Cases of excessive bleeding have also been reported, but less frequently than in former years. In addition to the foregoing a case has been reported of blocks shrinking excessively to such an extent that the blocks became loose in the streets. In view of these difficulties, particularly when taken in connection with the difficulty of obtaining both proper timber and creosote oil for its treatment, it is possibly not surprising that wood block paving has dropped somewhat in the estimation of some engineers.

Wood Block Troubles Within Control of Engineers

These failures, so far as the writer has been able to examine them, have been due, not so much to any inherent defect of creosoted wood blocks as such, but almost wholly to conditions entirely within the control of the engineer. Many valuable lessons have been learned as a result of these failures and in the following it will be the endeavor of the writer to give a brief analysis of the underlying causes with some suggestions as to how these may be prevented.

Divisions of the Problem

Any consideration of wood block paving may be grouped under these five headings:

First. Kind of timber to be used.
Second. Condition of timber.
Third. Preservative to be used.
Fourth. Treatment.
Fifth. Laying.

In 1916 the Committee on Specifications of the A. S. M. I. adopted specifications for the timber, condition of the timber, the oil to be used in treatment, and the treatment of wood block paving (see Proceedings 1916, pages 588 to 608). These specifications are in effect today with the exception of certain slight changes in the specification for preservative presented and adopted in 1918 (see Proceeding 1918, page 371). At the 1919 convention, the chairman of the Committee on Standard Specifications for Wood Block Pavements made the statement that these specifications appeared to be satisfactory and would insure a good, substantial, lasting block.

Taking up the individual headings:

Timber

Where the present specifications of the A. S. M. I. have been followed as to the kind and quality of timber, a reasonably dense, satisfactory block has been obtained and few, if any, failures have been reported because of the character of the wood used. In view of the failure of the sap wood of treated blocks, the writer has had numerous inquiries as to whether sap wood after all was not to be treated as a serious defect in a paving block. Sap wood as such, if sound, has all the strength qualities of heart wood. A study of the relative strength of sap and heart in Douglas fir shows that practically the weakest wood in the tree is in the center of the heart. The difficulty with sap wood is in the nature of the treatment rather than because it is sap wood.

Preservative

Preservatives used during the last few years, while they have not always been in accordance with the specifications of the A. S. M. I., have been more or less satisfactory and there has been very little complaint. The statement made by the writer before this organization in 1915 that the preservative is not the most vital part in

a successful wood block paving holds today as well as it did then. Where a good coal tar product is used with a fairly high percentage of high boiling compounds, failures will be few and far between; in fact, the writer has yet to see any failures of blocks due to the oil used where such oil was a pure coal tar compound.

Treatment

The treating specifications as at present prescribed have proven satisfactory in every way and there seems to be no reason to ascribe any of the recent failures to treatment.

Condition of Timber

The present specification provides that "the timber may be either air-seasoned or green, but should preferably be treated within three months from the time it is sawed." Recent experiences indicate that it may possibly be desirable to modify this clause to put a greater emphasis upon the necessity for having timber as thoroughly air-seasoned as possible—in other words, with a minimum moisture content. Reference has been made to failures due to decay. In 1915 the writer discussed in considerable detail failures which had taken place in various cities due to the decay of the sap wood of treated blocks and showed that this decay was due almost entirely to failure to obtain proper sap penetration. The sap decay of creosoted blocks has become more evident, not only on the streets then reported on, but on many new streets. Attention is again called to the fact that proper lasting cannot be obtained unless the blocks are thoroughly penetrated with the preservative, meaning by this at least perfect penetration of every part of the sap wood. Penetration throughout the sap wood can only be obtained in all cases if the blocks are as dry as possible. There is no question whatever but what many of the failures to obtain complete sap penetration are due to the fact that the blocks are not thoroughly dry and that water pockets were still present in the sap wood, thereby preventing complete penetration of the preservative. There is of course no use for laying a block pavement if one cannot be reasonably certain that it will be protected against decay so as to give the maximum length of life. No amount of steam treatment will make possible equitable distribution of creosote oil in a wet piece of wood. In this connection, it may possibly be of interest to explain that the initial steam treatment of paving blocks is for the purpose, not so much to get rid of water, as to assist in the driving out of the air, which is the principal factor causing bleeding after the blocks are laid in the street. Even if the use of thoroughly air-seasoned material did not appear warranted because of conditions to be described presently, it would nevertheless be necessary and desirable to treat air-dry timber for the sole purpose of getting better penetration than has frequently been obtained in the past.

Inspection

The present specifications of the A. S. M. I. call for careful inspection of the blocks after treatment by sawing a number of the blocks taken at random at right angles to the fibres through the center of the block. This is practically the only way in which one can detect the extent of the penetration of the preservative. In view of the sap failures, I strongly urge that at all times this method of inspection be rigidly followed at the time of treatment.

Laying

By far the largest number of failures of wood block paving in recent times has undoubtedly been due not to the blocks, but to the manner in which they were laid in the street. So much has been written about this subject in the past two years that it will hardly be necessary more than to indicate the present state of our knowledge of this exceedingly important factor. In the early days of laying creosoted wood blocks when more or less rough concrete foundations were used, the sand cushion came into use largely to give a smooth base on which to lay the blocks. During the period of its more extensive use difficulties of all sorts arose. The blocks bulged in spots after rain-falls, and after very heavy rain-falls whole street sections floated away. In many cases curbstones were thrown out of line. Another difficulty occurred due to the shifting of the sand base, giving irregular depressions and frequently holes. It has long been realized that the employment of the sand cushion was largely responsible for the unwelcome swelling and the displacement of curbstone and surface. Water found its way between the individual blocks and was absorbed by the sand at the bottom of the blocks. The latter then swelled more at the bottom than they did at the top with the resultant disturbances.

It is this unequal swelling of the blocks that has probably been the greatest factor in the failures during the past two years. So common have these local eruptions become that they are considered by some to be a necessary evil in connection with the wood block. In spite of the fact that these experiences are now of many years' standing it is surprising to find how many cities still use the sand cushion, particularly in view of the excellent results obtained in many cities with other methods.

Chicago Experience

As a result of experiences with the sand cushion, a number of cities adopted the plan of laying blocks directly on the concrete base either with a thin cushion of sand-cement mortar or frequently on a perfectly smooth concrete with a bituminous coating. The first street of this sort laid was Dearborn street, Chicago, between Adams street and Jackson Boulevard, put down in 1914. The east half of the street was laid on a mortar cushion and the best side on a smooth concrete base with a bituminous coating. The writer is indebted to Mr. Gabelman, Engineer of Streets, Chicago, for the following report on this street: "At the present time the west side of Dearborn street from Adams street to Jackson Boulevard is in excellent condition with the exception of a couple of cup holes. Two yards of maintenance would make it perfect. This side of the street is where the heavy trucks unload mail and should show much more wear than the east side of the street. The east side shows much more wear and is very uneven and is full of depressions."

Some St. Louis Experiences

Another street with which the writer is familiar, laid shortly after (1915), is 15th street, St. Louis, between Olive and Washington. This was laid on a concrete base prepared with a smooth finish, painted with pitch and the blocks laid directly on the pitch after it had cooled. It was then rolled with a light steam roller and the joints filled with pitch. This pavement is still in perfect condition. Very few pavements of this sort were laid, how-

ever, until comparatively recently. The abandonment of the sand cushion was followed most frequently with a sand-cement cushion, laid dry and moistened immediately before the laying of the block. In many cases this has not come up to expectations. If the sand was at all moist at the time of laying, a very poor bond was formed and the mixture acted practically like a sand cushion.

With the introduction of the smooth concrete base with a bituminous coating on which the blocks were laid directly, have come another series of problems of an entirely new character. In laying blocks on a sand cushion or on a sand-cement cushion, a filler of some sort was always specified to guard against admission of water between the blocks. Experience has shown, however, that even with the best care there was always sufficient space left to allow the water to percolate to the base of the blocks. Here it would stand for a short time and then be gradually absorbed by the base of the blocks, causing them to swell with consequent uneven expansion and heaving. With either the sand or sand-cement cushion there is, in other words, a material holding water in immediate contact with the highly absorptive lower surface of the blocks as distinguished from the bituminous surface which absolutely prevents water absorption. In some cases (see Horner, Engineering News Record, April 22, 1920) the filler when softened under extreme street temperatures, flowed down under the blocks in an irregular manner and increased the chances during sprinkling or rain-storm for water admission to points immediately underneath the blocks. With the use of a bituminous coating on a smooth concrete base, particularly after the blocks were rolled, an almost water-tight condition obtained at the bottom of the blocks. Explosions after rain-storms such as occurred on previous types of construction happened very rarely, if at all, on the bituminous concrete base. Blocks, in other words, were more or less protected from water on all sides except on the top. The amount of water absorbed on the top by the blocks was very small and usually disappeared rapidly by evaporation after the rain or sprinkling. There was practically no tendency for the blocks to enlarge. On the other hand, it was found in a number of cases that blocks thus protected from water absorption lost the water during periods of high temperatures in summer and tended to become loose. This condition is very elaborately described by W. W. Horner, Chief Engineer of Paving, St. Louis, in Engineering News Record, April 22, 1920, page 814. Three streets are described in this article. The blocks were laid on a smooth concrete surface, mopped with pitch at 140 to 145 deg. melting point and the blocks laid after the pitch had cooled. shortly after laying, the blocks contracted and became so loose that they had to be taken up out of the street, cleaned and relaid. On another street laid about the same time, where it was shady and the rate of evaporation of the water from the blocks was very much less, little difficulty was experienced as to shrinkage.

In the Oct. 7, 1920, issue of Engineering News Record, Mr. Horner describes the action of one of the streets last referred to, which had been laid in the summer of 1919 after the relaying of the street first mentioned where the shrinkage had been so high. The blocks in this second street were laid very tight, anticipating a possible shrinkage. In June of this year these blocks began to shrink just as they had on the street first mentioned. With an extremely ingenious device, fully described in the article cited, Mr. Horner took up the shrinkage, which amounted in one case to a total of 1.3 ft. in 125 ft. Careful attention is directed to the extremely interesting details presented in the article referred to. After the complete closure of the blocks on this street, with terrific rain-falls coming early in September, there was not the slightest movement on the pavement in any direction. An almost ideal condition has been obtained, namely, blocks were protected against water at the base by the pitch coating, on all sides by the pitch filler, and the tops of the blocks, while not quite as effectively waterproof, absorbed only small quantities of water which disappeared rapidly after the sun came out. In other words, the heaving effect due to the absorption of water at the base of the block was almost entirely obliterated.

Water Absorption and Water Loss

The great trouble breeder with wood block paving, aside from the question of bleeding, has been water—water absorption and water loss. Water absorption causes expansion which, when it takes place unevenly as it has done in the cases of the use of sand cushions and frequently sand-cement cushions, brings about upheaval in the pavement and entire destruction of the street during heavy rain-storms. Water evaporation has caused loose blocks and a constantly disturbed street surface. The ideal condition is one in which the blocks are so prepared that they may have a minimum amount of water in the wood to start with and then to have them so protected that they will have little opportunity for absorbing water. The nearest approach to such a condition will undoubtedly be obtained as indicated by Mr. Horner, by treating as thoroughly air dried timber as can be obtained, then laying the blocks on a smooth concrete foundation with proper pitch surface, taking care to lay the blocks as tight as possible, and then providing a thoroughly acceptable pitch filler. This practice is now being followed in some of the newer streets which have been laid in St. Louis.

Summary

Summing up the foregoing, experiences of the past few years seem clearly to indicate that the proper procedure to obtain maximum service from wood block pavements is to follow the specifications for timber, preservative and treatment prescribed by the A. S. M. I., with possible modification to the treatment specification looking toward the treatment of thoroughly air-dry timber. This should be followed by blocks laid on a thoroughly smooth concrete base with a good pitch coating, blocks laid as tight as possible, with a good pitch filler. When this procedure is followed, there seems to be no reason to anticipate any of the difficulties which have worried the street engineer during the past few years and should once again put this useful material to the forefront in all street construction.

This paper by Mr. von Schrenk was presented on Oct. 14, 1920, at the annual meeting of the American Society for Municipal Improvements.

EXPERIENCE WITH IMHOFF TANKS IN MINNESOTA

By J. A. Childs, Engineer, Division of Sanitation, Minnesota State Board of Health, St. Paul, Minn.

Those in charge of Imhoff tanks have encountered difficulties in certain instances with the operation of this type of settling tank. It may be of interest to record the experience with Imhoff tanks in Minnesota.

First Minnesota Installation

The first plant of this type was constructed in this State in the year of 1911, and since that time approximately 40 municipal and institutional tanks of this type have been installed. This does not include some two or three hundred small Imhoff tanks which have been constructed for the treatment of sewage from school buildings. Data based on experience in Germany was used in the earlier designs. It was soon apparent that the sludge chamber capacity of certain of these earlier installations was insufficient owing principally to the fact that the winters in Minnesota are relatively long and cold. During the cold winter months the bacterial action in the sludge compartments is very much retarded necessitating the holding over of a considerable portion of the sludge for summer ripening. The requirements of the State Board of Health now provide for a minimum sludge chamber capacity, below the settling compartment slots, of 2 cu. ft. per capita tributary to the system. It has been found that adequate sludge chamber capacity in nearly all cases eliminates the difficulty of having to handle partially ripened sludge.

Scum Troubles

Some difficulty has been experienced due to the excessive accumulation of scum in the vents. An instance of this kind occurred at the Faribault Institute for the Feeble Minded. This plant was constructed in the year 1914. The sewage reaching it is fresh and contains a considerable amount of soap and kitchen wastes. Soon after being put into operation, sludge began to accumulate on the surface of the vents until it had reached a thickness of approximately 10 or 11 ft. This floating sludge of scum was removed and instructions were given for the breaking up daily of scum accumulations. These recommendations were complied with and the plant has been in successful operation for a period of between three and four years. The scum in the vents is always loose and seldom exceeds a thickness of 12 ins.

The experience with the Faribault plant illustrates an extreme case where neglect caused the failure of the tank to operate satisfactorily and where intelligent care was all that was needed to obtain good results. The greatest difficulty appears to be to impress the local authorities with the fact that a sewage treatment plant is not an automatic piece of apparatus which can be ignored after being put into operation and expected to operate properly. The experience in Minnesota has demonstrated that plants of the Imhoff type, which are properly designed and intelligently cared for, will give generally satisfactory results. When all things are considered, there appears to be no type of tank treatment at present in general use which so well meets the operating conditions found at the average Minnesota municipality, as does the Imhoff type of tank.

METHOD OF STRENGTHENING AND RECONSTRUCTING HIGHWAY BRIDGES FOR HEAVY MOTOR TRUCK TRAFFIC

[Editor's Note:—The following discussion is the full text of the report of the Committee of the American Road Builders Association on the above subject, of which Mr. Willis Whited, Engineer of Bridges, Pennsylvania State Highway Department, is chairman.]

Shall we continue to endanger the lives and property of the people by criminal neglect of the highway bridge?

It has been estimated that more than 80 per cent. of the highway bridges are a distinct menace, due to one of two things—original construction not strong enough for modern traffic demands, or deterioration of the structure.

The life of a bridge is long. Thousands of those now in use were built before the motor traffic era. Failures of some of these structures prove the immediate need of strengthening or replacing these antiquated bridges so that they will carry not only the truck of the present day, but also the much heavier trucks and tractors of 20 years hence.

The motor truck is with us to stay. Its usefulness is steadily increasing, and is being recognized more and more all the time. Nobody who followed the history of the truck trains both in France and in our own land during the war has the slightest doubt of the fact that heavy truck transportation is not a dream of the future; it is an accomplished fact.

Truck Traffic

However, heavy trucks are, generally speaking, efficient only on improved roads, although the lighter trucks can run over dirt roads for a large portion of the year.

As the use of trucks becomes more general, it logically follows that the demand for improved roads will grow more insistent. The bridges on these roads will naturally be strengthened as the roads are paved. However, the use of the branch roads as feeders for the main roads is bound to increase, and it is right here that the engineer must look to his bridges.

The use of a road by loaded trucks is limited strictly and absolutely by the strength of the bridges on that road.

The Motor Bus

The motor bus is following in the wake of the truck. While this does not impose any new burdens from a technical standpoint, it greatly increases the danger of loss of life in case of the failure of a bridge. Moreover, these motor buses do not confine themselves to the main highways, and there will be a constantly increasing tendency to use them on dirt roads for sight-seeing purposes, and for reaching the more remote districts; for instance, the buses that gather up the children to take them to the modern township school, which in so many places has replaced the old district school.

Period of Service

Most of the States have passed laws limiting the weights of trucks, the maximum allowable weight, as a rule, being in the neighborhood of 28,000 lbs. This limit is fixed more to determine the liability of truck drivers and public officials than as establishing a final limit for the weights of trucks. Whenever the economy of heavier

trucks is established, which will be when better methods of constructing pavements and better materials and designs for tires, etc., are introduced, it is fair to presume that the legal limit will be raised.

A well-designed, constructed and maintained reinforced concrete bridge will, as far as we can see, last for centuries. A first-class steel bridge, properly kept up, will last at least 50 years and probably much longer. Trucks considered now to be heavy may appear puny in 1975. The engineer, therefore, is using good economy in looking well into the future in designing new bridges. The cost of the additional strength is a comparatively small proportion of the total cost of the bridge, and is trifling compared with what it would cost to strengthen it when that becomes necessary, as it surely will before very many years. If, however, an old bridge is to be strengthened, it is only a makeshift at best and the engineer is not justified in looking many years ahead in deciding on the assumed loading.

About 400,000 Highway Bridges

In the course of an investigation by a committee of the New York Legislature, it developed that there were in that State, about 33,800 public highway bridges more than 5 ft. in span, which would indicate that there are about 400,000 such bridges in the United States. It is safe to say that the failure of any one of a very large proportion of them would be liable to cause loss of life. It is also probable that more than 80 per cent. are unable to carry a modern heavy truck with a reasonable margin of safety. It will thus be seen what a colossal task it would be to replace all of them with modern structures, and also to what an extent the bridge engineer is the custodian of human life. We will not hazard a guess as to the total cost of such replacement, but it would probably amount to several billions of dollars.

Annual Inspection of Bridges

Every bridge should be inspected at least once a year by a competent man. A majority consist of a single span of wooden stringers with plank floors. In the case of such bridges the main points to be observed are the safety of the abutments, the sufficiency of the width, the safety of the railings, the adequacy of the waterway and the strength and soundness of the stringers and planking. All these points require sound judgment and reasonable amount of engineering knowledge. With the larger bridges the responsibility is greater and the danger of loss of life in case of failure is also greater. Many bridges require inspection oftener than once a year. All steel bridges should be painted every three or four years by competent men who are carefully instructed to report all defects observed. Many parts of steel bridges are not accessible for proper inspection without the use of scaffolding such as painters use. It is not always practicable to employ such scaffolding during the annual inspection. In preparation for the advent of heavy trucks all public bridges should be examined by competent men who will make a record of the character of the traffic likely to come upon the bridge, the dimensions and conditions of all vital members and the sufficiency of the details, and written reports of such inspections should be forwarded to the proper State Department for record. From these reports it must be decided which bridges require complete reconstruction, which require new superstructures, and which can be repaired and strengthened. The necessary plans can then be prepared and should be checked on the ground. Copies of all inspection reports should, of course, be filed with the proper local authorities, especially if they have charge of the bridges, but the State can better afford to employ competent men, and records kept in the State Capitol are less likely to be lost than those stored in local offices.

Strengthening Old Bridges

The strengthening of old bridges often requires far more engineering skill and ability than the design and construction of new ones.

The committee does not consider that in deciding whether any given member of a bridge needs strengthening, it is necessary to hold strictly to the letter of the standard specifications in the matter of unit stresses. In fact, a deficiency of 20 per cent. in material is not serious, provided the details are good and the material is in good condition, it being felt that the usual unit stresses adopted make that much allowance for deterioration, besides secondary stresses, etc., less allowance, however, should be made in the case of floorbeam hangers, stringers and floorbeams which are subject to widely and rapidly varying stresses. In considering the strength of a bridge truss it is not necessary to assume that the bridge is packed full of trucks of maximum weight, but if the bridge is 16 ft. wide or over, it is always possible that two heavy trucks may pass on the bridge.

The committee feels that, in cases where a bridge must be rebuilt or where the strengthening would make it, in effect, a permanent structure, it should be designed to carry a truck weighing at least 20 tons, with no allowance for impact.

Determine and Post Safe Loads

The committee fully recognizes that the immediate strengthening of all bridges in the country that need it together with the reconstruction of those which cannot be economically strengthened is a physical as well as financial impossibility. It would, therefore, recommend that immediate steps be taken to have a thorough examination made of all important structures by competent engineers and their safe loads determined and indicated by proper signs to the end that the public be protected so far as is humanly possible. Any person who disregards these notices and suffers disaster has only himself to blame. The work of preparing plans for strengthening should then proceed without delay so that construction can be taken up as rapidly as possible.

Steel Truss Bridges

The small bridges will generally have to be rebuilt, the steel truss bridges will generally be found fairly strong in the trusses but altogether too weak in the floor system. Many steel bridges have suffered seriously from neglect of painting and maintenance. Very frequently the steel about a foot above the bridge floor is very badly corroded. In such cases tension members would have to be reinforced, which can generally be done if they are of structural shapes, but if the bridge is pin-connected, the bridge can be supported on falsework and new tension members inserted. Corroded compression members can very often be effectually and permanently strengthened by concreting in the corroded parts. The concreting should extend beyond the corroded parts far enough to

secure sufficient adhesion. Defective details will generally have to be corrected, even at considerable expense. The attempt is sometimes made to strengthen a truss by placing another alongside it. If this is done great care must be taken that each truss carries its share of the load. The floor system should be supported on falsework and disconnected from both trusses, which swing free, and then connections should be made to both the old and new trusses. The upper bracing should be connected to the new trusses also to give them lateral stiffness. If the stringers only are somewhat weak their number can be increased at quite a moderate expense. If the stringers are very weak they should be replaced with new ones of sufficient strength. Weak floorbeams can generally be strengthened by riveting on new cover plates. The hangers should be carefully scrutinized for defects as well as for design, and if necessary, replaced with stronger ones.

Miscellaneous Methods

Few of the steel truss bridges are strong enough to carry paved floors, although many can be refloored with 2 x 4-in. creosoted wood set on edge and spiked closely together. This will give a much more durable floor and one much less likely to break through under heavy loads. The weight is but little greater than that of a plank floor.

Plate girders can often be strengthened by riveting on additional cover plates. Riveted lattice trusses can often be reinforced to carry paved floors without throwing away any existing material. Pin-connected trusses can rarely be strengthened and occasions frequently arise where it is necessary to support the floor by means of timber bents, consisting of piles, if the bottom is soft; or by means of mud-sills and posts, if the bottom is hard. If they are used they should be placed under all the floor beams, the outer posts being about 2 ft. inside the center lines of the trusses. This method, of course, is not suitable if the stream is likely to carry much drift wood or floating ice. Timber truss bridges can often be strengthened. If as is frequently the case, the floor only is weak, it is generally possible to put in heavier timber in the floor or to strengthen it with steel to carry heavy trucks. Stone arches are almost always amply strong to carry the load if they are in good repair, but it is sometimes necessary to remove the earth covering and grout the joints between the stones to give them full bearing. Stone arches, moreover, will usually show signs of distress long before total failure. It is rarely possible to strengthen a plain or reinforced concrete arch. If a truss is weak it seldom increases its strength to place bents under the floorbeams unless all the floorbeams are supported in the same way, taking the load almost entirely off the trusses. Plain concrete arches are more likely to fail suddenly without warning than almost any other kind of bridge.

Contract and Day Labor Systems

As to how this work of strengthening should be carried out much depends on circumstances. Estimates of cost are sometimes misleading. Unit costs of repair or alteration work in place are often more than twice the unit costs of similar material in new work. When an engineer starts to repair an old bridge he is almost certain to find a considerable amount of work that must be done that he had not anticipated. For these reasons it is usually best to have the material furnished or fabricated by contract and the field work done by day work if a reasonably efficient gang can be organized. Expensive equipment such as pile-drivers, air-compressors, etc., may be rented on a per diem basis. If it is a well-defined job such as replacing a floor system, or an abutment, it can be done satisfactorily by contract; otherwise a bidder is confronted by the same difficulty as the engineer in estimating his cost and will either bid high to cover risk and uncertainty, or will bid reasonable prices expecting to make up with his bill of extras, which will be no small item. Another difficulty often encountered in a repair job handled by a lump-sum contract may be illustrated as follows: The engineer estimates $10,000 as an outside figure for the job, he secures an appropriation of $15,000 to cover extras; the bidders have no way to estimate accurately their cost and are apt to be guided by the amount of the appropriation and bid about $14,900 leaving far too small a margin for extras. If an efficient gang cannot be organized, the cost plus system is generally the best. One difficulty that must be considered is that of insuring that the work can be done within the appropriation.

Steel truss bridges are nearly always fairly well designed except sometimes the details are weak, that is to say, if they are weak at all, they are correspondingly weak throughout. If it is desired to strengthen them as a whole, e. g., so as to carry a paved floor, it is almost always about as cheap to scrap the bridge and build a new one as to reinforce the old one. Besides if the former is done a modern well-designed bridge of ample strength will result. Otherwise the result will be an unsightly makeshift which will have to be repaired again in a few years.

If a bridge is at the foot of an incline, as is often the case, trucks are likely to cross them at a high rate of speed, which not only increases the stress, but also increases the danger to life and limb, to say nothing of property, in case the bridge fails.

The question of detouring traffic while a bridge is under repair is often quite difficult. It is frequently possible to support the old bridge with bents and maintain traffic over the bridge during repairs, although this method adds considerably to the cost of repairs. Sometimes a timber trestle can be built alongside or in the vicinity.

If a bridge is to be replaced it is sometimes possible to move it bodily sidewise on temporary supports and construct new temporary approaches.

The list of bridges which have failed under heavy trucks, with or without loss of life is a long one. In the vast majority of cases it is only the planking or the stringers which have broken through.

Legal Aspects

The courts have decided that it is the duty of the driver of a vehicle to make sure of the safety of a bridge before he crosses it, a duty of which he is often incapable, it being frequently a highly technical matter. He will usually be guided by experience. If a bridge has been crossed by heavy loads it will be considered safe for the same load again. This may be true and may not, a structure that is overstrained will be weakened thereby, although it may not fail immediately. "The last straw breaks the camel's back."

In submitting alteration plans for bids, they should be made as complete as practicable and should guarantee

all dimensions which the contractor cannot readily verify. Dimensions not guaranteed should be sufficiently accurate to enable the bidders to make close estimates of the quantities of materials required.

All requirements regarding maintenance of traffic, etc., should be clearly stated and if the work must be done at certain seasons of the year or certain days of the week or at certain hours of the day the fact should be clearly stated.

All matters concerning right-of-way, encroachments, etc., which may lead to law suits should, of course, be handled by the local officials; juries are much more generous to the local public than to out-of-town contractors or counties or States. Besides, a law suit is far more vexatious and expensive to a contractor than to the local public.

Giving the Contractor a Fair Deal

It is generally best for the public to assume all practicable risks; i. e., to eliminate the gambling element from contract work so far as possible. Every competent contractor adds to his bid an amount sufficient, in his judgment, to insure against all risks. It is usually best to give him every incentive to reduce the damage from flood and bad weather to its lowest limits. The contract should provide that the contractor should have an extension of time in case the work is necessarily delayed by bad weather, fire, flood or other accident. Similar provisions regarding delay due to strikes, delays in transportation, congestion of the material market, etc., should be contingent on the contractor having, in good faith, done the best he could under the circumstances. Prophetic wisdom should not be assumed to be an attribute of a contractor.

An excellent plan is to allow the contractor a certain number of working days to do the work, the time to be reckoned from the time he receives orders to start work. In that way, proper allowance can be made for bad weather, flood, etc. The principal difficulty in the case of steel work is that the material is frabricated under cover, independently of the weather, and is delivered on the site ready to erect, but there are frequently long delays in procuring the material and getting it fabricated. It would evidently be useless to order the contractor to start work on a job before his material had arrived on the site, and, on the other hand, the delay in obtaining and fabricating the material might be unwarranted. It would, therefore, be better, in this case, to allow a certain gross period for delivering the fabricated material and a certain number of working days for doing the work at the site. The former period would depend very much on the state of the material market and the facilities for fabricating which may be available at the time. This, in turn, would depend somewhat on the magnitude and character of the job. If heavy timber is required there is often a considerable premium demanded for delivery from stock, besides allowance must be made for more or less waste. In such cases, if haste is demanded, a sufficient premium must be allowed for prompt completion to make it an object for the contractor to obtain the required timber from stock. It may be difficult, however, to frame up a legal contract containing that provision. The courts object to paying bonuses on public contracts.

It is good policy to make a job as attractive as practicable to the bidder. A contractor is likely to bid high on a job he does not want very badly. A repair or alteration job is not generally very desirable on account of the large amount of supervision required and the frequent vexatious emergencies that arise, which combine to make the overhead cost all out of proportion to the amount of material used. Besides such jobs require a higher grade of skill and intelligence in the workmen than ordinary pieces of work. A highly skilled workman is likely to get disgusted with that kind of proposition. There is not infrequently much difficulty in finding a contractor who is willing to be bothered with a repair job. Often the best man is a small contractor who has nothing else to do, if such can be found.

Rebuilding a Bridge

If it is decided to rebuild the bridge, a proper investigation must first be made by a competent engineer to determine the required waterway and the type, span and width of bridge to be built. Frequently a new location is preferred, if not, the old masonry must be rebuilt or altered. The old way was to employ a local stone mason who had no proper equipment for foundation work in the river, to put in the masonry. If the bottom was quite soft he would drive piles and saw them off about on a level with the surface of the water, cap them with planks and build rubble masonry upon them. The masonry was usually much too thin with little or no mortar in the backing, due to lack of inspection. The result was that in a few years, the timber foundation decayed and the wall cracked and settled and had to be repaired under circumstances that made it very expensive. If the ground was fairly firm the contractor would excavate a few inches below the surface of the water and build masonry as above described. Sooner or later a flood would undermine the foundations and serious damage if not destruction of the whole structure would ensue.

The modern way is to employ an engineer to design masonry of proper strength and thickness, usually of concrete or concrete faced with stone founded on piles if necessary. The work is let to a contractor who does that kind of work and is equipped with proper pumps, pile-drivers, derricks, concrete mixers, etc., to do a good job in a reasonable time. The foundation is carried to a depth sufficient to avoid all danger of undermining by scour. If piles are required, they are driven and the excavation pumped out so that the piles can be cut off well below the bed of the stream. The excavation is carried some feet below the tops of the piles and filled with concrete enveloping the tops of the piles and the whole masonry carried up to completion. If the bottom is soft, either the bed of the stream is paved or the masonry is protected with riprap. A job is thus completed that will probably last for centuries, at a cost not much greater than by the old way, allowance being made for increased prices of labor and materials. Everything is done under the eye of an inspector supervised by an engineer who insists on an honest workmanlike job. If the superstructure is of concrete or stone it is designed with proper strength and the materials and workmanship tested and inspected so that the public gets a good bridge at a reasonable cost.

If the superstructure is of steel the problem is somewhat different. The old way was to receive bids on a lump-sum basis from contractors who furnished their own plans. The specifications stated the capacity

strength, etc., but there was nobody representing the owner to see that the specifications were compiled with, and the contract was likely to go to the man who had the most "nerve" in skinning down the quantities of material. Little attention was paid to durability or ease of maintenance and the honest contractor was gradually forced out of the business. There was no inspection by any competent representative of the purchaser to see that the workmanship and material were according to specifications, and the contractor was at liberty to play any tricks he saw fit. The bridge was then painted with some cheap and worthless paint and opened for public use. The result was that thousands of bridges have been built with a margin of safety very near the vanishing point and at prices which should have been sufficient to pay for a good bridge.

The modern method is to employ a competent engineer who prepares plans for a bridge which will be as safe and convenient as possible, providing extra material in parts that are peculiarly subject to wear and tear and special protection for any parts that need it and the requisite number of coats of first-class paint. The plans, specifications and information are so prepared as to reduce to a minimum the expenses of the bidder in preparing his bid and to make the job look as attractive as possible.

The work is advertised in the local papers to comply with the law and also in one or more of the periodicals that make a specialty of such work, and are, therefore, widely read by contractors. The advertisement is of reasonable length, but gives sufficient information to enable any contractor to judge fairly well whether he wants the job. Information regarding the work is given to the information bureaus which make a specialty of notifying contractors of work to be let. The engineer also notifies, in any suitable manner, any contractor he knows who could handle the work. This last should be done in such a way as to prevent any combination being formed among the bidders. After the bids are opened and the contract duly awarded according to law, the contractor prepares his shop drawings and submits them to the engineer for approval, after which they are signed by the proper officers, including the engineer. The contractor then orders his material and goes ahead with the shop-work. All material and workmanship are carefully inspected by competent men, preferably selected by the engineer and paid by the purchaser. The mill and shop inspection can generally be done at least as well and more cheaply by a regular inspection firm and the field inspection either by the same firm or by a salaried inspector appointed by and acting under the supervision of the engineer. After the bridge is erected it is thoroughly cleaned and painted with the requisite number of coats of first-class paint carefully applied.

Unit Price Versus Lump Sum

The question arises as to whether work should be paid for on a unit price or lump-sum basis. If proper facilities are available for accurately determining the quantities, the unit price method is usually the best, then if minor changes are found desirable as the work progresses, nobody suffers any injustice. If the lump-sum plan is adopted, there is more certainty that the cost of the work will not exceed the appropriation, which is under many circumstances, a very important matter. In contracts for bridge masonry there is generally considerable uncertainty as to the depth to which the foundation must be carried. This can only be determined as the excavation progresses. The contract should be so drawn that no injustice is done if the depth of the foundation is much greater or less than shown on the plan. All plans for lump-sum work must, of course, show full details.

Appropriations and Engineering

It behooves the more intelligent citizens, as well as the engineering profession, who realize the necessity of a reasonable margin of safety, to convince the press and the general public of this necessity to the end that liberal appropriations may be made for the purpose of making proper inspections, repairs, alterations and reconstructions and also of the fact that much of this work is highly technical and must be placed in the hands of experts.

If the number and importance of the bridges involved is sufficient to justify it, competent men should be employed at adequate salaries to make inspections and repairs. Such men will make proper studies of traffic conditions and the peculiar dangers and conditions of each particular structure and act accordingly. They will take care of the most dangerous bridges first and, as funds are generally quite limited, will see that available funds are made to go as far as possible and that no work is undertaken for which there is not an adequate appropriation.

If the number of bridges is too small to justify the employment of a salaried engineer, one who is not connected with any concern engaged in constructing or furnishing material for bridges should be employed on a per diem basis.

It is the duty of officials in charge of public highways to maintain them in such condition that they are safe and convenient for all reasonable and lawful traffic which may come upon them; and the limit of loading on bridges of a State should be fixed by statute in order to determine what are reasonable and lawful loads. It being understood, always, that any private parties desiring to transport heavier loads on them than is provided for by statute, can do so by paying the extra cost of making the bridges of the desired strength.

EXISTING MACADAM BASE FOR BITUMINOUS PAVEMENTS

By George C. Warren, President Warren Brothers Company, 142 Berkeley St., Boston, Mass.

(Editor's Note—The following discussion by Mr. Warren was based on papers presented on this general subject at the recent annual convention of the American Society for Municipal Improvements by Mr. Julius Adler and Col. R. Keith Compton. Mr. Adler's paper is published in this issue).

While confessing to be one of those who from the first, and especially during the past ten years has broadly and persistently urged and successfully practiced to a very large extent the great economic conservation value of old macadam roads as a foundation for stable bituminous surfaces, I believe I am not one who has not appreciated and not expressed caution of its limitations.

First, Be Sure of the "Macadam"

Of course, the so-called "macadam" must be either real macadam of either stone or gravel and of substantial strength and depth or it must be reinforced with new stone added to and compressed into the old macadam. A small percentage of stone or gravel in a large percentage of clay or other weak material is not macadam. Nor is a road which some may call "macadam" (but which in reality is merely a veneer of indifferently spread stone on a weak sub-soil) a suitable foundation for any street pavement wearing surface without substantial reinforcement by the addition of new metal. On the other hand, in nearly all cases where any stone or gravel has been spread and compressed on the sub-grade, there is at least a great salvage value which should be conserved.

In City Streets

In city streets, especially those having street railroads, it is necessary, in some cases, to remove some of the old macadam to provide against a too shallow gutter at the curb or too high a pavement surface grade at the railroad track. In most city streets, however, none of these conditions arise if the engineer will as closely as practicable follow the original contour and will not provide an exposed face of curb higher than is necessary to take care of surface drainage. In some cases a few additional catch basins may be necessary to reduce the flow of surface water in the gutter, but they can be provided at only a fraction of the waste necessary to remove the old macadam either as a whole or in part.

On Country Roads

In country road construction almost universally the necessary slight raising of the elevation of the pavement surface is advantageous and not detrimental. In other words, the higher the road surface is above the surrounding country, the better the drainage and more successful the pavement, whatever its foundation or surface construction may be.

Rules of Procedure

A few rules may be laid down, to wit:

1. Never depend on surface appearance nor even on test excavations made a few weeks or months before construction to determine whether or not the old macadam will require renforcement.

2. Always make test holes, or, better, test cuts across the street or road at intervals of say 100 ft. immediately in advance of construction and from those test observations come to an intelligent conclusion as to the necessity for a depth of new metal required to provide the necessary strength of base which will doubtless vary on different sections of the same project. The quantity of new metal, if any, cannot be definitely determined in advance. Consequently, such reinforcement should be paid for per ton or cu. yd. of new material actually used and bids taken on that basis. It is wasteful to attempt to determine and specify in advance of construction how many, if any, inches of new metal is necessary over the entire road. Even if test excavations are made in advance of preparation of plans and specifications preparatory to letting a contract, traffic may very materially change the condition before the construction period has arrived.

3. Do not disturb the old macadam for change of grade or contour or by scarifying unless absolutely necessary. Any such disturbance more or less reduces the strength and consequently the conservation value of the old macadam and sometimes actually removes practically all of it in the center of the road.

If the crown is excessively high, better correct by building up the quarters and outer edges with new metal than to remove solid road metal from the center unless there is a greater depth of solid macadam in the center than is necessary.

4. In every case where there is any road metal on the street, however thin or weak it may be, it is better to leave it in place and conserve it for "all it is worth" than to remove it, especially in these times of high cost of labor and materials.

5. If such test excavation as recommended in rule 1 develops 6 ins. or more of solid metal (whether gravel or crushed stone) in which the coarse particles (ranging from ¼ in. to 2 ins. or more in size) are more than one-half the total metal so that the finer particles merely fill the voids, then no treatment is necessary nor advisable except to regulate the grade, "knocking off" the high and

COMMONWEALTH AVENUE, BOSTON, LOOKING WEST FROM DARTMOUTH STREET

Warrenite-Bitulithic Pavement Surfaced Over Old Macadam in 1916. Photo Taken October 5, 1920. Traffic 7 A. M. to 7 P. M. 13,718 Vehicles as Shown by Average of Two Day Traffic Records Taken Saturday, October 2, and Tuesday, October 5, 1920.

filling up the low places by scarifying, picks in the roller, or hand picks, as may be most economical in each case, and then thoroughly roll the thus "prepared base."

6. If such tests show that the fine particles predominate, or the depth is insufficient on the whole or any part of the macadam road or street, that condition does not justify excavation and wasting of the material, but just add to the old surface, after regulating its grade, whatever depth of new metal intelligent consideration of all the conditions indicates is best and safe. It will surely require much less labor and will be much less costly than to remove the old metal and supply an entirely new base.

7. If the drainage is poor, it should be corrected. A greater depth or more rigid type of base does not correct faulty drainage. On the other hand, faulty drainage can be corrected at much lower cost than by destroying the old macadam and furnishing new foundation.

Drainage All-Important

Before the A. S. M. I. and at other times and places, I have repeatedly made a statement to the effect that "from the days of John MacAdam down, the first thing practically every writer on road construction has said is 'drain,' but it is the one thing that most engineers fail to consider or intelligently practice in preparing plans." I

believe this engineering shortcoming is only somewhat less potent at this time than it was ten years ago. Specific reference to drainage is made in Col. Compton's paper. This failure to provide drainage is the prime cause for failures which bring out such statements as that of Mr. Adler in his paper, now under discussion, as follows:

> Macadam types were similarly damaged in some localities during the past winter and, in at least some of these places, there is a growing tendency to disregard the possible value of these roads and the investment in them.

This disaster during the past winter, or rather, spring, thaws was not at all confined to roads, the foundations of which were of "macadam types" nor to any special type or types of surface. In fact the trouble was uni-

A RESULT OF POOR DRAINAGE

Asphalt Block Pavement Laid on 6-in. Portland Cement Concrete Base. The Workmanship on this Contract Was of the Best in Every Respect. The Trouble is Due to Insufficient Drainage and Not to Type of Wearing Surface or Base. Note that the Road Bed is Several Inches Below the Adjoining Property—a Condition which in Itself Always Tends to Contribute to Drainage Trouble.

versal throughout New England, New York, etc., in places where drainage had been ignored or was faulty. The past winter was unusually severe in those sections, including protracted cold, excessive snowfall, and sudden spring thaws. The accompanying illustration of a type of block pavement surface on Portland cement concrete base is sufficient to illustrate the point. No one who examined the condition would fairly charge the destruction to either the type of surface or base. *It was simply faulty drainage.*

Note that, without curbing, the road surface is several inches below the abutting land—a condition which itself always invites drainage disaster, as it provides no outlet for surface drainage except to seep under the road. During that period (early spring of 1920) I had occasion to examine a road which had "exploded" for a length of about a mile. It was a rolling country and the middle of the damaged section was a sump, formed by long grades ascending in both directions. Of course this is a condition requiring most careful consideration of drainage, but none had been practiced and the consequent damage in one week's thaw in that one mile was about $20,000. Not only was no sub-surface drainage provided, but a telephone conduit had been put through the street without even installing lateral drains or "weep holes" for escape of water, which it should have been anticipated would likely accumulate in the conduit. For most of the distance the roadway was several feet above the abutting land, so that lateral drainage from the conduit would have been very simple and inexpensive. As a result of this oversight, during the thaw of last spring the telephone conduit became filled with water from sub-surface drainage and overflowed through the manholes.

It has been suggested that macadam base is applicable for block pavement. While confessing to no practical experience in this connection, I would advise against such practice until its sufficiency has been proved by several years' broad practical experience under varying conditions. My fear is that the irregularities of surface would prove disastrous. Surely the blocks could not be laid directly on the macadam, as is the practice in laying bituminous surfaces. If the blocks are laid on a cushion of Portland cement mortar over the macadam, the thin cushion would probably break up from traffic over the completed pavement. A sand cushion on the other hand would be more or less irregular in depth and probably cause the blocks to rock and settle unequally under traffic.

Stability of Bituminous Mixture

Attention should also be called to the importance of stability of bituminous mixture especially in connection with macadam bases. As an example of practical comparative experience—Commonwealth Avenue, from Arlington Street to Brookline Avenue, Boston, was surfaced in 1916 with Warrenite-Bitulithic laid over the old macadam without any new metal. This section of Commonwealth Avenue is the leading thoroughfare and carries the greatest volume of traffic in the city. Traffic records during twelve hours (7 A. M. to 7 P. M.) show the following:

Saturday, October 2, 1920.....	13,316 vehicles
Tuesday, October 5, 1920.....	14,120 vehicles
Average per day (12 hours).....	13,718 vehicles

No repairs in five years since laid and the present contour and surface are as perfect as could be. Two years later the section of Commonwealth Avenue to the Boston-Newton line, subjected to much less traffic, was improved by a fine aggregate asphaltic surface laid over the old macadam, and the surface is already quite badly undulated.

The specifications embodied in Col. Compton's paper suggest that after other preparation of the old macadam, a layer of crushed stone should be spread over and rolled into the old macadam " to form a coarse, grainy surface of fresh clean stone which will bond the bituminous paving material." Our quite extensive experience from the Altantic to the Pacific (Commonwealth Avenue above cited is one instance, and the three 12-mile approaches from Portland, Oregon, to Columbia River Highway another instance) brings the conclusion that such treatment is quite unnecessary and that the real test of requirement of new metal should be the one of depth and solidity of the old macadam as above outlined in some detail. Photographs of these two important prominent highways, proving the points under widely varying climatic conditions, are herewith reproduced.

PAVED HIGHWAYS FOR PRESENT-DAY TRAFFIC

By Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport, University of Michigan, Ann Arbor, Mich.

This discussion of "Paved Highways for Present-Day Traffic" will be confined to the consideration of traffic on interstate and intrastate trunk highways and the roadway requirements which should be met in order to provide properly for traffic development.

Highway Transport Surveys

An investigation of the probable traffic development on any highway outside of a municipality should be based upon what has come to be commonly known as a highway transport survey, which includes a consideration of all classes of traffic which might use the highway, rural and urban transportation opportunities and competing carriers including railway and waterway facilities. What are the several methods of transportation included in the general term, highway transport? It is evident that highway transport includes all methods of transportation of passengers and commodities over highways.

Rural Motor Bus Routes

We have been familiar, for many years, with the utilization of highways for the transportation of passengers through the medium of horse-drawn vehicles and runabouts, touring cars and limousines. A development in this field with which the highway engineer must reckon is the installation of motor-bus routes on highways outside of municipalities. England has had an enormous development in this field during the past 15 years. In this country, such development had gained a certain headway prior to the war, as indicated by the successful operation of 125 rural motor-bus routes in 1914 in the State of New York. Motor-bus routes have rapidly developed for the transportation of passengers between urban districts which are not adequately served by steam and electric railways. Another development along this line is the utilization of the motor-bus for the transportation of children to consolidated rural schools. The State of Michigan is at the threshold of this development and should give it thorough consideration at once in order to provide adequate and high grade educational facilities for its rural population. To give some idea of the development of traffic in this field, it is well to call attention to the fact that approximately 2,000,000 children living in 65,000 old rural school districts throughout the United States are now being transported daily throughout the school year to 13,000 consolidated schools.

Types of Highway Transport Requiring Consideration

The methods of transportation of commodities are many and varied. Restricting the discussion to the methods used outside of municipalities, we have first what may be called intercity haulage, which includes all methods of highway transport used for transportation of commodities between municipalities. We then have short and long rural haulage which includes all highway transport methods which utilize highways outside of municipalities except inter-city haulage and highway transport operating on definite routes according to service schedules. In this field is included transport by companies whose business is exclusively long and short distance trucking and the traffic resulting from the transportation of commodities by men engaged in farming, by wholesale and retail stores of our municipalities, and by the transportation departments of our plants, factories, lumber camps, mines and other industries using natural resources. There are several other methods of highway transport which require consideration but only one more will be mentioned, namely, the rural motor express, which pertains to the transportation of commodities on prescribed routes and, generally, according to schedule, in the field of commerce between rural producers and a terminal city, village railway depot or waterway dock. By analyzing the development along each of these lines of highway transport, we arrive at an estimate of the vehicular traffic which will use a given trunk highway.

Traffic Investigations in Rhode Island

In most cases, provision must be made for a rapid increase in the volume and weight of traffic units. For example, the writer has recently received results of traffic investigations in the State of Rhode Island. On one trunk highway, the daily motor truck traffic increased 1,113 per cent. between August, 1913, and August, 1920, the numerical daily increase being from 47 motor trucks in 1913 to 570 in 1920. On another trunk highway, the increase in automobile traffic from 1915 to 1920 was 102 per cent. or an increase in number of vehicles from 1,980 in 1915 to 4,008 in 1920, and an increase in this period of 659 per cent in the number of motor trucks, as in 1915, the daily average was 79 and in 1920, it was 600. These increases are due solely to the development of highway transport and not because the trunk highways cited were unimproved in 1913 and 1915, respectively. In considering these increases, it should be borne in mind that Rhode Island has had a large percentage of its trunk mileage constructed for many years as it started its highway development program in 1903 with a law which provided only for a system of state trunk highways to be constructed and maintained by and at the expense of the state.

Factors in the Problem of Design

The problem of the design of a highway from the standpoint of traffic resolves itself into a determination on the probable amount and character of vehicular traffic during a future period, the design of the grades, curves, and width of the road way so that it will be efficiently serviceable for the traffic which it is to carry, the determination of the amount and character of external forces to which the different parts of the highway are subjected and finally the design of the bridges, drainage systems, foundations and roadways so that they will have sufficient internal strength to resist the external forces during a reasonable period of time.

Influence of Truck Traffic on Design

The forces, due to motor truck traffic, which should be given consideration in the design of a roadway wearing course and its substructures are the direct load causing compression, impact forces, shearing forces of the driving wheels, and the resultant forces between the subgrade and the pavement foundation. Necessarily these forces are functions of the volume, weight, speed and character of the vehicles using the highway. These factors are determined as a result of information furnished by highway transport surveys and legislative regulations cover-

ing these factors. The best indication which we have of the probable normal maximum weights of vehicles to which highways will be subjected in the immediate future is the recommendation of a committee of the National Highway Traffic Association which was adopted at the 1919 Convention of the American Road Builders' Association and which was later incorporated in the Proposed Uniform Vehicle Law, which is supported by several national organizations. The above recommendation pertaining to motor trucks allows a load per linear inch of width of tire of 800 lbs. and a maximum gross load on four wheels of 28,000 lbs. These limitations, which have been embodied in the laws of several states, allow the use of motor trucks having a capacity of 7½ tons. In this connection, it should be noted that the Trailer Manufacturers' Association of America has advocated legislation limiting the weight on four wheels of a trailer, including vehicle, body and load, to 28,000 lbs. These recommendations give us a definite starting point for the design of pavements and their substructures. Although those who have given careful consideration to the probable development of highway transport believe that the economic and efficient development of this form of transportation will not necessitate, for many years, the utilization of motor trucks having a greater capacity than 7½ tons, nevertheless it is admitted that it may be desirable in isolated cases to transport over highways loads on four wheels in excess of the limit prescribed. The transportation of such weights, however, should be provided for by special legislation rather than be accepted as the fundamental basis for design. This matter has been properly handled in a regulation which has been advocated for inclusion in state status by the Trailer Manufacturers' Association of America. This section reads as follows: "Authority to be given to state, county, city and township authorities to issue special permits for the operation of vehicles exceeding the foregoing gross weights, weights per axle and weight per inch of tire over highways under their jurisdiction, provided the highways and bridges to be used are designated and operators of the vehicles for which permits are issued are made responsible for any damage that may be done to the highways and bridges by reason of such operation." The recent transportaion of a load of 100,000 lbs. on a single trailer would come within this provision.

Width of Pavements for Trunk Highways Carrying Heavy Truck Traffic

This discussion will be limited to a consideration of pavements suitable for interstate and intrastate trunk highways which will be subjected to an intensive motor truck traffic. The width of the pavement should first be given consideration. Roadways economically designed must provide for carrying the traffic on the paved roadway surface and not rely upon shoulders to carry a part of the traffic or serve as turnouts. It has been demonstrated that the latter practice is neither economical from the standpoint of the maintenance of pavements and shoulders nor is it efficient or safe from the standpoint of the traffic using the highway. In other words, we must provide for a minimum of two lines of commercial traffic and it is obvious that an operator of a heavy motor truck will insist upon allowing a certain amount of leeway between the outside wheels of the truck and the edge of the pavement since many operators have had unfortunate experiences with motor trucks being stalled in soft shoulders or ditched. Considering the factors of widths and speeds of passenger cars and motor trucks utilizing trunk highways and that the laws of many states permit a maximum width of 8 ft. for motor trucks, taken in conjunction with the rapid increase in the volume of traffic on trunk highways, the conclusion is reached that 20 ft., for the width of the pavement surface of a trunk highway, should be considered the minimum. There are highways where the normal traffic requires provision for two lines of vehicles and the abnormal traffic particularly on holidays, Saturday afternoons and Sundays will render the adoption of 24 to 26 ft. justifiable. This is due primarily to the fact that provision should be made for vehicles standing at the side of the road while temporarily requiring repairs. While traveling on a highway in the vicinity of Detroit on a Sunday during July, 18 vehicles parked at the side of the roadway, and under repair, were passed in 15 minutes on a 5 mile section. If the transport survey indicated that the normal amount of traffic will require provision for more than two lines of vehicles, a greater width than 20 ft. must be adopted, the additional width depending upon the character of the traffic. It does not require much imagination to reach the conclusion that many interurban highways will be subjected, during the next decade, to traffic which will necessitate roadways sufficiently wide to accommodate at least four lines of vehicles, which would mean a width of 38 to 48 ft.

Materials of Construction

For the classes of trunk highways under consideration, the roadway wearing course should be composed of a brick, cement-concrete (plain or reinforced), bituminous concrete, sheet asphalt, wood block, or a stone block payment supported by a reinforced concrete, plain cement-concrete, bituminous concrete or heavy stone foundation. The selection of the particular type will depend upon many local economic factors and the results of the transport survey.

One Motor Vehicle to Every Fourteen People in U. S.

If these recommendations relative to the requirements of present-day traffic on trunk highways are not considered conservative, contemplate the following facts pertaining to the increase in the use of motor vehicles during a period of five years. In 1914, the total registration of motor vehicles in the United States was 1,711,339, while in 1919, it was 7,558,848. This means 1 motor vehicle to every 14 persons throughout the Union. In Michigan, the 1919 records show that there was 1 motor vehicle to every 10 persons. During this same period of 5 years, the number of motor trucks in use increased from about 136,000 to 750,000. A conservative estimate indicates that the registration of motor trucks in 1920 will exceed 1,000,000.

The highways outside of our municipalities have had a changeable status during the past 30 years and the reasons advanced for their improvement have been many and varied, but mostly sound. Fortunately, there has been rapidly developing throughout the land a conviction that highways are merely a means to an end and that that end is the economic and efficient transportation of passengers and commodities. It has become self-evident that unimproved and improperly built highways consti-

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"Tarvia-KP" is known as the road-maker's "Cure-All". It is wonderfully effective for every type of road—quick-acting, always ready; requires no heating and is extremely easy to handle.

Batches of the mix can be made up in spare moments and used whenever the roads are free from snow. Freezing does not injure it.

If you have a road problem put it up to our Special Service Department. Illustrated booklet showing each step in patching a road with "Tarvia-KP" free upon request to nearest office.

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tute a positive barrier to the development of economic highway transport. In order that highway transport should take its proper place in our transportation system, the following fundamental guiding principle must be accepted generally: Highways should be designed, constructed, and maintained so as to enable them to carry efficiently the motor vehicles required for the rapid development and economic utilization of highway transport.

The foregoing paper by Prof. Blanchard was presented at the annual convention of the Michigan Good Roads Association held at Lansing on Sept. 2, 1920.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS

The 1920 annual convention of The American Society for Municipal Improvements, which was held in St. Louis Oct. 12-15, was very generally considered by those in attendance as the most successful convention the Society has held in recent years. There was an exceptionally interesting and full program of papers presented and the response by the delegates to the papers, in the form of discussions, was spontaneous and on a high professional plane.

The committee reports on recommended standard specifications were a feature of the convention this year as always. The committees deserve much credit for the hard work done in standardizing specifications covering the various phases of municipal engineering work.

There were several round table discussions, during the luncheon periods, at which matters of interest to the members were presented for consideration and acted upon. Thus the schedule of salaries for engineers in municipal service, as adopted by The American Association of Engineers, was presented in one of these round table discussions and later taken up on the floor of the convention. After presentation and discussion on the floor of the convention this schedule of salaries was approved by unanimous vote.

During the war this Society, perhaps, suffered somewhat from the prevailing depression in municipal engineering activity, but the very successful convention of this year is thought to reflect the very greatly improved status of municipal engineering affairs. It is confidently believed by all interested in the welfare of the Society that during the coming years it will attain a period of influence and artistic success in its field unsurpassed by any other professional organization in the country. The editor begs leave to invite the support of all interested in the making of public improvements, for this Society, which has a distinct field of usefulness. It is hoped that workers in this field will feel that they should support the Society by membership and, when possible, by attending its meetings.

The convention arrangements in St. Louis merit specific comment and commendation. The delegates were unanimous in their praise of the results of the great work done by the St. Louis committee in charge of all the convention arrangements and details. We believe that all those interested in municipal improvements and, therefore, in the vigorous growth and development of this particular Society are indebted to the St. Louis men who gave so much of their time to making this recent convention a decided success.

Several of the leading papers presented at the convention are published in this issue of "Municipal and County Engineering." That we are giving more space in this number to the papers presented at this convention, than

VIEW IN EXHIBIT ROOM AT ANNUAL CONVENTION OF THE AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, ST. LOUIS, MO., OCTOBER 12-15, 1920.

has ever been devoted before in this journal to the proceedings of any convention, is the best evidence of the impression made upon the editor as to the merit of typical leading papers on the 1920 program.

Col. R. Keith Compton, Chairman and Chief Engineer of the Paving Commission of the city of Baltimore, was elected president for the coming year, and Charles Carroll Brown, Dean of the College of Applied Sciences at Valparaiso University, was re-elected Secretary. The 1921 convention will be held in Baltimore.

PROPOSED LEGISLATION AFFECTING COUNTY ENGINEERS

The temporary legislative committee of the Oklahoma Highway Engineers has recommended and the highway engineers have adopted the following proposed legislation:

The county engineer shall be appointed by the board of county commissioners. He shall have charge of and be superintendent of all maintenance and construction on the public highways of the county, and of one county only. The minimum salary to be paid in counties with a valuation of ten million dollars or less shall be $2,100 per annum. Where the valuation is from ten to twenty million the salary shall be a minimum of $3,000 per annum; twenty to thirty million, $3,600 per annum; thirty to fifty million, $4,200 per annum; fifty million or over, $4,800 per annum.

The law governing the destruction of roads to be made more clear and more stringent. The load per bearing inch and maximum of any wheel to be limited.

All construction work to be performed under the direction of the county engineer to be approved by the state highway department before construction is authorized by the county commissioner.

WATER WORKS SECTION

MAKING USE OF UNUSUAL GEOLOGICAL FORMATION PERMITS CARRYING OUT NEWARK, N. Y., WATER SUPPLY PLAN

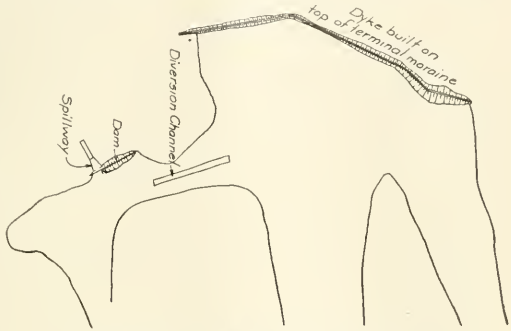
By James P. Wells, Hydraulic Engineer, Cutler Bldg., Rochester, N. Y.

Previous to the construction of its gravity water supply system, Newark, N. Y. had suffered for some time from a lack of water. It was suggested by the writer that it would be possible to get a gravity supply by going some eight miles to the south. Though the city commissioners had been searching for some ten years for a new water supply and the gravity plant had never been thought feasible, the writer was commissioned to make an investigation and report with estimates of cost of bringing water to Newark by gravity.

There is probably no other locality in the northern part of the United States which shows so clearly the effect of glaciation as the district in which Newark lies. A glance at the topographic maps of this region will show hundreds of drumlins running north and south. The greater number of the small streams flow to the north in between the drumlins.

Topographical and Geological Conditions

An investigation was made of several streams and it was found that a good supply of water could be obtained from one with a drainage area of about six square miles providing it were possible to build a storage reservoir large enough to store about 225,000,000 gals. A survey was made and the survey indicated that it would not be feasible to construct a reservoir with a capacity greater than 75,000,000 gals., and that even with a reservoir of this capacity it would be necessary to construct a small dike on the east side of the reservoir to prevent the water from going over into an adjacent valley. The writer made an examination of this adjoining valley and found there was a terminal moraine cutting across the front of it and that while this valley had no tributary drainage area to speak of, that a dike could be constructed at a relatively low cost on top of this terminal moraine and the basin thus created would provide additional storage. The water would simply have to be diverted into the basin from the main stream and the water in both valleys would be kept at the same level, and by this means the capacity could be increased to 225,000,000 gals. In order to divert the water into the adjoining valley and have sufficient depth at the divide so that both portions of the reservoir could be drawn upon, it was only necessary to excavate a channel for a short distance from a maximum depth of 10 ft. The writer submitted his report with estimates of cost and an appropriation was voted in March, 1919, to carry out the proposed work.



MAP OF IMPOUNDING WORKS OF GRAVITY WATER SUPPLY FOR NEWARK, NEW YORK.

Runoff Estimated

Case Creek, the stream upon which the dam has been constructed, has a drainage area slightly in excess of six square miles. From the records of adjacent streams it was estimated that in an extreme low year the average daily runoff for the entire year would be at least 3½ million gallons per day. The runoff during the early part of the year is sufficient to keep the reservoir filled until the latter part of May or June. There is occasionally a year when there is very little runoff for as much as five or six months of the year beginning with July, and for this reason it was considered advisable to build a reservoir large enough to supply the desired quantity of water for six months of the year even if practically no

CORE-WALL OF DIVERSION DAM FOR NEWARK, NEW YORK, GRAVITY WATER SUPPLY SYSTEM.

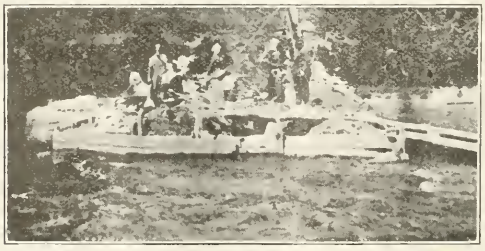
Printed as insert to MUNICIPAL AND COUNTY ENGINEERING, Chicago, Ill., November, 1920.

water came into the reservoir. The present supply is about 1 million gals. a day and to make sure of this supply being always available a reservoir of 225,000,000 gals. capacity was constructed. This gives a liberal allowance for seepage and evaporation.

Earthen Dam and Dikes

Test pits on the site of the work and other conditions indicated that an earthen dam with a concrete core-wall and dikes of the same nature would be the most economical type of construction. The foundation for the dam on the main stream was for the most part clay underlaid with shale rock, though at one end was a bank of gravel. As has been mentioned above, in the case of the adjoining valley, the dike had to be built on the terminal moraine and this was composed of gravel. As this dike would have to be of considerable length, nearly one-half mile, it was evident that there would be considerable seepage underneath the dike when the reservoir was first filled with water. The dike was built with a concrete core for the greater part of its length, but in the lower portions no core was used. The core extends into the gravel about 8 ft. As was expected, when the reservoir filled there was considerable seepage underneath the core-wall. This has gradually decreased, and judging from experience with other reservoirs should stop entirely within a year or two. The stream entering the reservoir carries considerable silt in flood times and as this silt settles in the reservoir the seepage is taken up.

The material for the earth fill was excavated by steam shovels loading into dump wagons, and for the low sections of the dike by scrapers. The material was put down in layers. The embankment has a top width of 10 ft. The upstream slopes are 2½ to 1 and the down stream slopes 2 to 1. Rip rap 1 ft. thick was placed on the upstream side of the reservoir. The spillway was built in the dam on the main stream. It has a width of 80 ft. and its crest is 5 ft. below the top of the earth fill. The entire spillway, including the over-flow portion, wing walls and the paving of the spillway channel rest upon shale rock.



COFFER DAM USED IN CROSSING CANANDAIGUA LAKE OUTLET NEWARK GRAVITY WATER SUPPLY.

Concrete

The core-wall of the dam is built of Class "C" concrete in proportions 1, 3 and 6. As this core-wall serves the purpose of preventing water from going through the dam the specifications permitted the use of local gravel. While this material was not of the best quality, it made a tight wall and the cost of the concrete was much less than it would have been if it had been necessary to bring in the gravel. The contract price for the concrete in the core-wall was $7 per cu. yd. In the construction of all exposed concrete, imported gravel was used of the very best quality. The over-flow portion of the spillway and the side walls were built of Class "B" concrete, 1, 2½ and 5. The paving of the spillway channel was built of Class "A" concrete proportioned 1, 2 and 4.

Filtration Plant

The drainage area of the storage reservoir is practically all farm land and there are a number of dwellings and other buildings on the watershed. The main stream comes into the reservoir about a mile away from the intake, so that there is an excellent opportunity for the water to improve greatly in its condition before reaching the intake. It was considered necessary, however, to construct a small filtration plant before turning the water into the mains. This filter plant is of the rapid sand type. The water is first aerated and from the aerator flows through a Venturi Tube into the sedimentation basin. By means of the Venturi Tube the amount of chemical, sulphate of aluminum, is proportioned to the amount of water used. From the sedimentation basin the water passes on to two filter beds, each of which have a capacity of 500,000 gals. per day. The sub-structure of the filtration plant is of reinforced concrete and the superstructure of brick with an outer layer of tapestry.

CHANNEL DIVERTING WATER FROM MAIN STREAM OVER INTO ADJOINING VALLEY, NEWARK, N. Y., WATER SUPPLY WORKS.

Pipe Line

Leading from the filtration plant is a 14-in. cast iron pipe. Its total length is about eight miles. For the greater part of its length it was found possible to lay the pipe underneath the highway, and by that means to save the cost of a private right-of-way. A considerable amount of rock was found in the line and the greater part of this had to be drilled and blasted. Two streams, both of a width of about 200 ft., had to be crossed. At these crossings a trench was excavated in the bed of the stream 3 ft. wide and 3 ft. deep. A few inches of concrete were laid in the trench, the pipe placed on top of it and thoroughly embedded and the trench filled with concrete so that the concrete was flush with the bed of the stream.

Work Cost Less Than Estimate

The writer estimated that the entire undertaking would cost $330,000, including lands purchased and rights-of-way. As a matter of fact the work has cost only $300,000, $30,000 less than the estimate.

Personnel

The plans and specifications were prepared and the work done under the supervision of the writer with offices at 249 Cutler Building, Rochester, N. Y., and 103 Park Avenue, New York City. E. P. Strowger was resident engineer in charge of construction. The Norwood Engineering Company, of Florence, Mass., were the contractors for the filtration plant, the United States Cast Iron Pipe and Foundry Company, of Burlington, N. J., for the pipe, James F. Leary & Co., for laying the pipe, and Lupfer & Remick, of Buffalo, were the contractors for the dam.

REMOVING IRON FROM PUBLIC WATER SUPPLY AT SHELBY, OHIO

By Philip Burgess, of Burgess & Niple, Consulting Engineers, 141 East Broad St., Columbus, Ohio

It is a well recognized fact that the presence of a considerable quantity of iron in a public water supply is objectionable, but unfortunately there are comparatively few instances where such public water supplies have been developed and improved by purification, so that it is believed that the experiences of The Shelby Water Company, at Shelby, Ohio, in the development of a ground water supply containing considerable quantities of iron will be of general interest.

Historical

The water works at Shelby were installed by the local water company in 1897, and the supply was obtained without treatment from drilled wells 40 to 60 feet deep, contained in a 10-acre tract bordering on Black Fork Creek and situated about one mile above the center of the town. Preliminary tests were made of the quality of the supply and the report of the analyst under date of October, 1896, contained the following:

> The water is very high in free ammonia, rather high in albuminoid ammonia, pretty well up on oxygen required. The water is a suspicious water. I should suspect it of containing animal sewage well fermented, but not exposed to oxidation. The practical absence of nitric acid may mean, however, that the free ammonia is largely due to nitrates reduced to ammonia by working through soil and rock containing reducing agents, possibly sulphide. This is theory, however, and a full investigation of these features will be necessary before this water could be considered safe, as the analysis, on the face of it condemns it. This latter theory would be supported by the large amounts of sulphates (permanent hardness).

The analyst's statement indicating that the water was "suspicious" is of interest and indicates the general lack of information relative to the significance of organic matter in ground water supplies. Bacterial analyses have always indiciated that the water supply at Shelby is practicaly sterile so that the high organic matter contained in the water is of no significance as regards its sanitary qualities. It merely indicates that the water takes up organic matter from the alluvial deposits which are swampy and contain considerable deposits of a decayed vegetation probably of pre-historic times.

First Iron Removal Devices

Use of the water supply at Shelby soon indicated that it was generally very unsatisfactory for domestic purposes on account of its high iron content and some 8 years later, in 1905, the company installed devices to remove the iron. These included aeration through perforated, horizontal, steel baffles in the top of the stand-pipe, sedimentation in the stand-pipe, and finally, filtration through two horizontal, steel pressure filters 8 ft. in diameter, by 24 ft. long. The filters contained 18 ins. of crushed quartz, having an effective size of 0.75 mm. The water was improved by these devices and the iron reduced from approximately 7 parts per million to about 0.6 to 0.8 parts per million.

While associated with the Ohio State Department of Health, the writer made an examination of the plant of the company in 1909 and numerous chemical and bacterial tests of the raw and treated waters were made at the plant.

At that time the total consumption of water was from 250,000 to 300,000 gals. daily. The iron was reduced to a little less than 1 part per million and the consumers were generally satisfied with the quality of the supply. Subsequently the water consumption at Shelby has increased until, during the past year, the consumption has been about 700,000 gals. daily, or double that during the year 1909, with the result that the removal of iron by the purification devices available was not at all satisfactory. The writer was retained by the company to design a new iron removal plant and subsequently his firm entered into a contract to construct this plant from the design furnished.

Description of New Iron Removal Plant

The general features or principles adopted in the new plant were similar to those in the old and comprise aeration, sedimentation, and filtration. The supply is the same as that originally acquired but the old drilled wells have been abandoned by the company and have been replaced by two dug wells, approximately 45 ft. deep. The new plant was designed for a normal capacity of 1,000,000 gals. daily. The aerator tower was based upon a normal capacity of 17 gals. per sq. ft. per minute. The aerated water is retained in the sedimentation or reaction basin for a period of one hour. The filters have a normal capacity of 100,000,000 gals. per acre daily. The clear well holds 250,000 gals. of treated water, equivalent to 6 hours' storage. The filters are covered with a substantial brick superstructure. All of the basins and filters are of reinforced concrete.

During operation of the new plant, water is pumped by electrically operated centrifugal pumps from either of the wells and is discharged at the top of the aerator through which it flows by gravity into the reaction tank, thence on to and through the filters into the clear well from which it is pumped by electrically operated centrifugal pumps under about 60 lbs. pressure, into the distribution system or stand-pipe. The latter is 16 ft. in diameter, 130 ft. high, and holds 196,000 gals.

Aerator

The aerator comprises 3 horizontal trays containing crushed coke. The trays are 12 ins. deep with 12-in. openings between trays. The bottoms are covered by wire screens containing 3½ meshes per inch composed of iron wire 0.105 in. in diameter. The coke layers are 12 ins. thick and are comprised of particles ranging in size from ½-in. to 3-ins. diameter. The trays are each 4.5 ft.

by 9 ft. in section with a total area of 40.5 sq. ft. The nominal rate of flow through the coke is 17.3 gals. per sq. ft. per minute. The aerator is located over the inlet end of the basin and water is distributed over the top tray by two lines of perforated 8-in. cast iron pipe. The centers of these pipes are 8 ft., 8 ins. above high water level in the basin.

Reaction Tank and Filters

The basin or reaction tank is uncovered and is 14 ft. by 43 ft. by 10.5 ft. deep. It holds 47,300 gals. so that the period of retention in the tank is 66 minutes.

The filters are 2 in number and are open gravity sand filters, each containing 240 sq. ft. The total filter area is 0.011 acre.

The strainer systems comprise 10 in. cast iron main collectors and 1½ in. extra heavy galvanized iron laterals 6 ins. apart. The laterals are perforated with ¼-in. round holes spaced in two rows, six holes per lineal foot of pipe.

Over the strainer system is the filter gravel placed to total depth of 12 ins. and comprised of particles ranging from 1/12 in. to 2 ins. in diameter.

Above the gravel is placed 2 ft. of filter sand with an effective size of 0.49 mm. and uniformity coefficient of 1.75. Considerable thought was given to the selection of sand of the proper size and experience indicates that the sand used is entirely satisfactory.

The filters are washed through a 10-in. cast iron pipe connection from the stand-pipe and the rate of application of the wash water is from 20 to 24 ins. rise per minute. The tops of the wash water troughs are 24 ins. above the filter sand.

An unusual feature of the design is that high water in the clear well is 3 ft. above the bottom of the filters so that the total effective depth available for filtration is 3 ft., when the clear well is full. No controllers are provided in the effluent pipes on the filters. It is obvious that as the clear well becomes full, water backs up on the filters tending to reduce the head available for filtration and consequently to reduce the rate of filtration. This feature permitted considerable saving in the construction and operation of the plant. Moreover, the total head available for filtration has proven to be ample, notwithstanding the fact that it is customary to keep the clear well full.

Operation of Plant

The new iron removal plant at Shelby was first placed in operation on March 19, 1920, and has continued in successful operation since that time. It is of interest to note that the elimination of iron from the supply has been entirely satisfactory from the beginning of operation.

The actual results accomplished by the plant have been determined from time to time by analyses of samples collected by the superintendent of the company and shipped to the laboratory of the State Department of Health, at Columbus.

In general the iron content of the well water is high, ranging from about 5 to 8 parts per million in well No. 2 and 16 parts in well No. 1.

Analyses of the samples obtained from the supply to the filters indicate but slight change in the chemical and physical qualities of the water as effected by aeration. Later tests made by Mr. Roberts, Assistant Engineer of the State Department of Health, indicate that the dissolved oxygen content of the raw water was increased by aeration from 0 to 64 per cent. saturation and that the free carbonic acid is decreased by aeration from 43 to 16 parts.

Analyses of the total iron content are of especial interest and indicate that the filtered water at times contains only a trace of iron in the samples. The highest iron content shown at the plant is 0.3 part per million and from the mains in March, was 0.4 part per million. The increase of iron in the main as compared with that in the filter effluents was caused by the former deposits in the mains. It will be of interest to see how long these deposits continue.

In general the operation of the plant has been entirely satisfactory and the filtered water supply has been always clear and free from suspended iron.

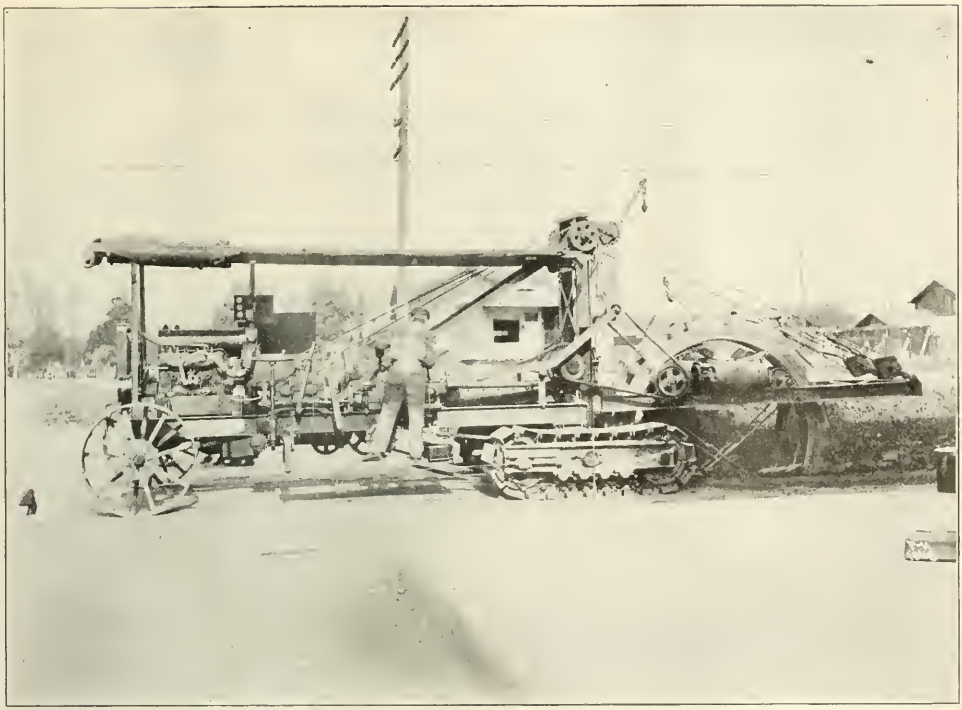
Experience indicates that the coke in the aerator tends to become coated with deposits of iron so that it is necessary to wash it every three or four weeks. This is done by washing the coke in place with a hose. But little sedimentation of iron occurs in the reaction tank, which is cleaned only once or twice yearly, and even at such times contains but a few inches of deposited precipitate. The filters are washed once daily at the rate of a little less than 24 ins. rise per minute and generally for a period of 4 or 5 minutes. The total quantity of wash water used is only about 4 per cent. of the quantity of water filtered so that in this respect, the operation of the plant compares favorably with that of similar rapid sand filter plants provided to improve surface water supplies.

The contract under which the writer's firm constructed the clear well and filters included all excavation and concrete structures, except the reaction tank which was built by the company; also the pipe lines except outside cast iron pipe lines. It did not include the brick superstructure nor back filling and grading around the clear well and filter house. The total contract price for the above was $16,500. Mr. Bricker, president of the company, has advised the writer that the superstructure cost about $1,500 and the aerator and reaction tank about $3,000 additional. It will probably cost about $800 to complete embankments and grading around the new plant so that the total cost of the new plant was about $23,000.

The Plant a Success in Every Way

In conclusion it should be noted that the recent experience of the company in providing a new iron removal plant has been entirely satisfactory and in fact, has proven beneficial in a number of ways. The satisfaction to the officials of the company in providing a clear water supply free from objectionable features, and to the consumers who are enjoying the new supply is very pronounced. Moreover, the new plant has resulted in a marked increase in quantities of water sold, thereby increasing the revenues of the company due in part to the more abundant use of water by former consumers and in part to new consumers who have been attached to the property since the new plant is in operation. Mr. Bricker has advised the writer that, during the past five months, the company has acquired more new consumers than they experienced during all the preceding five years.

Another feature of operation brought about by the



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This machine will cut trenches from 18 to 21 ins. wide and 6 feet deep, and the trench may be either straight or curved.

Cost of trenching is reduced to the lowest point, as this is a truly one-man machine.

Whether the work is the average easy job, or one calling for exceptional excavator strength, this Wheel Type P & H Excavator will work rapidly. It has established performance records that has won leadership for quick, cheap and accurate trenching in any kind of material in which an excavator can be operated.

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Ask for Descriptive Bulletin IX.

Pawling & Harnischfeger Co.

EST. 1884

MILWAUKEE, WISCONSIN

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"You see them wherever you go, and they go wherever you see them."

P&H — excavators — back-fillers - tampers

new plant is that it is now very much easier to maintain service lines and meters than was formerly possible. With the use of raw water there were many instances where service lines became clogged with the deposits of iron thereby resulting in a loss of considerable sale of water and a considerable increase in expense entailed for maintenance of service lines. Similarly the iron contained in the water supply formed deposits on the meters eventually with the result that there was a general reduction in the quantity of water sold, not always apparent to the officers of the company. There is no question but what the sale of water and revenues received therefrom were materially reduced by the above features, which are now eliminated by the operation of the new iron removal plant. In general the relations between the officials of the company and the consumers are much more satisfactory, a condition which has resulted in increased income and benefits to the company and increased enjoyment and use of the public water supply to the consumers. The benefits derived from the new plant have more than compensated the company for the expense entailed by its construction and operation.

The above matter is the major portion of a paper by Mr. Burgess as presented at the 1920 meeting of the Central States Section of the American Water Works Association.

METHOD OF GRADING CITIES ON FIRE SERVICE EMPLOYED BY NATIONAL BOARD OF FIRE UNDERWRITERS

By Clarence Goldsmith, Assistant Chief Engineer, The National Board of Fire Underwriters, 234 S. La Salle St., Chicago, Ill.

Before considering the "Standard Schedule for Grading Cities and Towns of the United States with Reference to their Fire Defenses and Physcial Conditions," as prepared by the National Board of Fire Underwriters, it may be well to answer the question "What is the National Board of Fire Underwriters?" said Mr. Goldsmith in addressing the recent annual meeting of the Indiana Sanitary and Water Supply Association.

What is the National Board of Fire Underwriters

At the outset a little elimination will aid in reaching an understanding:

The National Board of Fire Underwriters is not a "fire insurance trust." It is not a corporation. It is not in any respect a money-making concern. It has no legislative powers over the business. It has no jurisdiction over companies or agents. It has had no rate-making functions since April, 1876, nor any jurisdiction over rates and premiums. It has had nothing to do with commissions or compensation of agents since July, 1886.

The National Board is an educational, engineering, statistical, and public service organization maintained by the stock fire insurance companies, and its membership includes nearly all of the important companies in this class. Theoretically, the service that it renders is to its membership, but practically, it has become to all intents and purposes a public service institution in most of its activities. This is due to the fact that for more than a generation, efforts in the direction of fire prevention have assumed a larger and larger part in the work of the Board, and fire prevention is essentially a public matter. Its work is carried on through the following committee: Actuarial Bureau, Adjustments, Clauses and Forms, Construction of Buildings, Finance, Fire Prevention and Engineering Standard, Incendiarism and Arson, Laws Membership, Public Relations, Statistics and Origin of Fires, Uniform Accounting, and Loss Information Service.

While a committee on Fire Prevention had existed since 1892, its present work is the direct outgrowth of the Baltimore Conflagration in 1904, when it was brought home to the fire insurance companies with special force that the increasing congestion of values in cities, where they could be affected by great conflagrations, represented a serious menace both to the public and to the fire insurance business. The crowding of populations into city limits in itself produced a fire hazard which called for expert study and systematic measures for fire protection and prevention. The Committee on Fire Prevention and Engineering Standards handles the engineering work for the Board.

Standard Schedule for Grading Cities

A natural development of the study of water supplies, fire departments, fire alarm systems and structural conditions has been the preparation of a Standard Schedule for Grading Cities and Towns with Reference to their Facilities for Fire Protection. The first step in the preparation of this schedule was the establishment of standards covering the different items entering into the various features of fire protection and prevention. The classification of any given city is determined by the application of points of deficiency depending upon the extent of variance from these standards, which were formulated from a study of conditions in more than 500 cities. The total maximum points of deficiency amount to 5,000 and the plan of having ten classes of cities or towns has been accepted.

The system has been adopted by insurance organizations having rating jurisdiction in the greater number of states and the application of the schedule is being actively pursued by these organizations and by the National Board in the larger cities. The results of the application of the schedule in respect to the fire protection improvements secured and the records of saving resulting therefrom have been very encouraging. The Standard Grading Schedule has been found to create a spirit of good will and cooperation on the part of city officials and civic organizations, and is believed practically to eliminate discrimination in city or town classification.

In the formulation of the standards for the different items not only the data collected by the committee in connection with its inspection work, but the standards commonly accepted by municipal and consulting engineers, when such had been established, were considered. These standards once established, apply in all cases, there being no separate standard for a small town and another for a large city. The fire defenses of a city are considered under the following main subjects: Water Supply, Fire Department, Fire Alarm, Police, Building Laws, Hazards, including those of lighting, heating, explosives or inflammables, and Structural Conditions.

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these several subjects. When the individual city is graded an additional deficiency is applied when the climatic conditions, such as winds, snowfalls, cold weather and hot, dry weather, vary from the normal conditions throughout the country, and further provision is made for making an additional charge when there is a material divergence in the classes of the fire department and water supply. It is manifest that where protection is furnished by a most excellent water supply and the fire department is seriously weak in men or equipment, that the full value of the water supply cannot be utilized in fighting fire, neither could a fully manned and well-equipped fire department operate at its maximum efficiency if the water supply was seriously deficient. The relative values of points assigned to the several subjects were carefully weighed and considered. The number of points assigned to water supply when the city is on the engine stream basis is 1,700, and when on a hydrant hose stream basis 2,000 points; to fire department when the city is on the engine stream basis 1,500, and when on a hydrant hose stream basis 1,200 points; fire alarm, 550; police, 50; building laws, 200; hazards, 300, and structural conditions, 700 points.

Water Supply Section Has 32 Items

The 43 items in the Water Supply section of the schedule will be discussed in detail. These items are divided into three main classes, dealing with organization, adequacy and reliability, respectively.

Personnel

In order that a system may be efficiently operated the tenure of office of all employes should be secure. In municipally owned works this can best be assured by civil service rules, properly administered. Civil service does not secure ideal conditions, but in general is found to be the most satisfactory means of precluding political influence; the object to be obtained is long tenure of office and an efficient organization.

The chief executive, who may be called either the superintendent or chief engineer, should be competent and qualified by experience, preferably supplemented by education to fill the office efficiently. A competent executive, although without extensive experience in waterworks engineering, when associated with experienced engineers, frequently secures satisfactory results, particularly in the direction of the larger systems.

Records

In order to operate efficiently and design economically for future growth, it is necessary to have accurate and complete records; these should include a skeleton plan, showing the general location of mains, gates, hydrants, reservoirs, standpipes, pumping stations and other works connected with the system, preferably on a scale of from 600 to 1,000 ft. to 1 in. The sizes of mains up to 8 ins. in diameter may well be indicated by symbolic lines and those of larger sizes by figures. When the larger mains are drawn with heavier lines than the others the map will give a comprehensive idea of arterial system. All closed valves, including those along service limits, should be clearly indicated. Where the information is available, contour lines at convenient intervals should be added to the map; where these are not available the known elevations should be put on in figures, and in any case the exact elevations of the flow lines of all storage should be given.

The exact location of mains, gates, hydrants and larger service connections, and where desirable all service connections should be shown in detail on sectional sheets on a scale of from 40 to 60 ft. to 1 in. Where mains are not connected at street intersections this should be clearly shown, and it is desirable to note on these sheets the date when the mains were laid.

For the operation of the distribution system one or more sets of valve location books should be provided. These should be sufficiently in detail to enable intelligent operation of valves at complicated street intersections, and the location of the valves on large service connections should be included. A card index of valves should be kept showing location, make, type, size, direction and number of turns to close, depth below street surface, date set and all other necessary detail. A sketch showing the diagrammatic location of the valve with the ties may be placed on the reverse side of the card. Records should be kept of all repairs, inspections and operation of each valve; these may be in separate form or combined with card index.

Hydrant data, including location, date of installation, make, type, number and diameter of outlets, diameter of barrel, valve and branch, direction of opening, whether there is a gate on the branch, and other necessary information should be kept in card index form. Each hydrant should be given a serial number and records of inspection, condition and repairs should be kept either separately or on the cards.

Each service connection should be assigned a number and all data, including street number of property served, date of installation, kind and size of corporation and curb cock, pipe, curb box and stop and waste and meter, if provided, should be in card index form; a sketch showing location may be provided on the back of the card.

Consumption records should be kept in such form that the average daily consumption for each year, month and week and the maximum weekly, daily and hourly consumption can be readily obtained. This can be most readily accomplished by use of a meter of the Venturi type, having a continuous recording mechanism, although moderately accurate results can be compiled from the pump plunger displacement by making proper allowance for slip. Where reservoirs and standpipes are in service records should be kept of water levels, preferably by continuous recording devices. Complete records of pumping plant operation should be maintained in accordance with the prevailing modern practice. Continuous recording pressure gages should be maintained. One should be located in the principal mercantile district and others at such points as may be desirable.

Co-Operation Between Fire and Water Departments

The department should have a crew available at all times on short notice to handle emergency work and a motor vehicle equipped with tools should be available. At least one responsible employe should respond to fire alarms in mercantile districts and to second alarms elsewhere.

Fire alarms should be received in some quarters of the department and in all direct pumpage systems at the pumping station. Where pressures are raised or pumps are started upon receipt of fire alarms, fire alarms should be transmitted to the pumping station over duplicate fire alarm circuits. The foregoing standards of organization should assure the efficient operation of the system.

Adequacy of Water Supply

In considering the adequacy and reliability of a system it should be kept in mind that the function to be performed is to furnish domestic consumption and to get water on the fire. In order to determine the adequacy of the source of supply these requirements must first be determined. The records should show the average daily rate of domestic consumption and the maximum water consumed during any day within the last three years. In estimating the required fire flow an allowance is made for probable loss from broken connections and hydrants left open incidental to a large fire. Including this quantity, the total fire flow may be determined by applying the usual formula. In all cases consideration must be given to the structural conditions as found in the city and also to the number of companies in the fire department and the outside aid that would be available in case of a large fire. Illustrative of the application of the formula, a fire flow of 4,500 gals. a minute is required for the protection of the principal mercantile district of a city having a population of 22,000 and 12,000 gals. a minute for a city having a population of 200,000; cities having a population of over 200,000 require from 2,000 to 8,000 gals. a minute in addition to 12,000 gals. for a second fire.

Where fire engines are depended upon, the ability of the system to deliver the engine supply at a pressure of 20 lbs. in the mains is considered the ultimate capacity of the system. This residual pressure in the mains is deemed necessary to overcome the frictional losses in suction hose, hydrants and hydrant branches and to provide the necessary velocity head in order to deliver water to the fire engine in volume equal to its rated capacity.

Pressure

The pressure on the mains when the fire draft is being made, which is required to develop direct hydrant hose streams, is dependent mainly upon the height of the buildings; 75 lbs. pressure or more, depending upon the height of buildings and engine capacity in service, is necessary in high value districts; 60 lbs. where not more than 3 stories, and in closely built residential districts, and 50 lbs. in village mercantile districts, where buildings do not exceed 2 stories and in thinly built residential sections. If the fire flow available at these pressures is in excess of the engine capacity available, plus 1/3 the required fire flow, or if there are no fire engines, the protection is considered as being on a hose stream basis and the deficiencies in the water system to furnish the required quantity at the desired pressure are worked out, otherwise the deficiencies of the water system are based on the capacity of the system to deliver water at 20 lbs. The adequacy of the system is based upon all equipment and appurtenances being operated under normal conditions which obtain at time of fire.

The advantage of having pressures sufficient to deliver 10 per cent. of the required fire flow as hydrant streams is recognized, and where systems do not have this capacity an additional deficiency is applied in proportion to the number of pounds below the required pressure at which this quantity is available. Consideration is, however, given to the reliability of the source of supply, inasmuch as it may be influenced by droughts, floods, ice

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formations, silting-up or shifting of channels, physical condition of intakes, forest fires, danger from earthquakes and injury by physical means, and a deficiency is applied in proportion to the unreliability, bearing in mind that a total interruption of the supply is more serious than a reduction in the quantity available.

Reliability of Water System

Now that the adequacy of the system has been determined, the question of reliability in respect to its ability to maintain its normal capacity under various conditions is considered. Records maintained over a number of years show that certain failures, which result in partially or completely interrupting the supply, occur with sufficient frequency to merit consideration.

The number and total capacity of the pumps should be sufficient to allow maximum domestic consumption and the required fire flow to be maintained when the two largest units are out of service. The quantity of water held in storage and available to supplement the output of the group of pumps under consideration is taken account of in calculating the deficiency. Where there are low-lift as well as service pumps, the reliability of each group is considered separately and a deficiency charge is made for each.

Suitable credit is given for emergency supplies when available in proportion as they offset the deficiencies of the several parts of the system. The utilization of polluted supplies is not advocated and where such are available and have been used, credit is given for only ½ the points which these supplies decrease the deficiency of the system, because they will probably not be used until conflagration conditions have developed.

Boilers

A sufficient number and total capacity of boilers should be provided to deliver the required capacity as previously determined with one-fourth the entire capacity, and in any case one boiler in reserve. Where chimney capacity is ample, an overload of 50 per cent. for return tubular and 100 per cent. for water tube boilers over the maker's rating is allowed and credit is given for available water held in storage. Normally, there must be sufficient boiler capacity kept under at least ½ required pressure to deliver full requirements, in connection with storage, for a period of 2 hours.

Pumps

All equipment must be of a design suitable for the service, maintained in good condition and operated by a competent force. Pumps of the following types, when well designed and installed, are assumed as approximately equal, the advantages of each, if any, being in the order of their naming; centrifugal or reciprocating pumps driven by steam engines; centrifugal or reciprocating pumps driven by electric motor (the generating stations must meet the same requirements for reliability as those imposed on pumping station); pumps operated by water power; centrifugal or reciprocating pumps operated by internal combustion engines.

The supply of fuel must be assured and at least 5 days' supply should be kept on hand; oil should be kept in underground storage. Where gas or oil supply is unreliable, provision should be made for the use of coal. Any deficiencies in water power should be offset by a second source of power held in reserve.

Transmission Lines

Steam, gas, oil and feed piping or electric transmission lines should be so arranged that the failure of any line, or the renewal of any valve, transformer or oil or feed pump would not prevent maintaining, in connection with storage, maximum domestic consumption for 2 days and fire flow for 10 hours. In determining the unreliability of overhead electric lines consideration must be given to the character of poles and wires and of country traversed; prevalence of high winds, sleet and snow storms, and facilities for making repairs; the use of the same transmission line from transformer or switchboard by other parties introduces an undesirable hazard.

Fire Protection in Water Works Structures

Pumping stations and other portions of the plant should contain no combustible material in their construction; otherwise an automatic sprinkler equipment must be provided. In any case the stations should be protected against exposures and hydrants and inside standpipes with hose and chemical extinguishers should be provided. If pumping station is not fireproof, the several sections, particularly any with high-potential generating or transforming equipment should be separated by parapeted fire walls and openings protected by at least a single, standard fire door or wire glass in metal frame. Electric wiring shall be installed in accordance with the National Electrical Code, and all internal hazards, such as oil and waste, properly safeguarded.

Breaks in Supply Line

The effect of a break in any pipe or conduit line on which supply to the distribution system is dependent must be considered in determining the reliability of the supply mains. Aqueducts of good design and of substantial construction, such as masonry or concreted steel, when reliably installed, shall be considered sufficiently dependable as not to require duplication. In determining the failure which will result in the greatest reduction of the supply, all mains which deliver from the source of supply or of storage to the principal mercantile district must be considered; these will include suction or gravity lines to pumping stations, flow lines from reservoirs, force mains, as well as arterial feeders within the distribution system. In determining the effect of any break the storage available must be considered, and in calculating the quantity available from such source it is assumed that 5 days will be required to make necessary repairs. In designing suction and discharge headers, piping at reservoirs and filters, by-passes and cross-connections, particular attention should be given to the feature of reliability. This feature is frequently overlooked and single failures result in complete or serious reduction in the supply, when little or no additional expense would have been involved to provide the necessary reliability.

In determining the points of deficiency for the preceding items which pertain to reliability, except for that covering pumping station buildings, it is recognized that the probability of large fires occurring while any portion of the works is out of service is not so great in the smaller cities and the points of deficiency are reduced 10 per cent. for each 1,000 gals. fire flow required below 5,000 gals.

Pipe Lines

In addition to the effect produced by a single break the probability of such a break occurring must be considered.

Cast-iron, wrought-iron, wood-stave, reinforced concrete and masonry conduit have been found satisfactory in various places and under certain conditions, but account must be taken of the general condition. The service record should be taken into consideration in judging of the reliability of these lines, together with the probability of their failure at stream crossings and railroad crossings, where physical injury might occur; it is preferable to have mains laid far enough apart so that they will not endanger each other. The mains should be cross-connected about once a mile and equipped with suitable valves and blow-offs to enable shut-offs and repairs to be made promptly. Such mains are considered moderately unreliable when the repairs of one valve would result in the total interruption of the supply.

The deficiency of the arterial system is based upon the results of the fire-flow tests and a general consideration of the arrangement of the large mains. These should be of sufficient size to deliver the required flow into the several districts in addition to the maximum daily consumption rate, and so looped that no large area will be dependent upon a single main; in general, large mains should be so spaced that they will not be over 3,000 feet apart.

The large mains should not be laid in filled ground and should have special construction at railroad crossings and near bridge abutments; cover must be sufficient to prevent freezing and at least 2 feet is required to prevent injury from traffic. Gate valves should be set at intervals of not more than ¼ mile, and where connections to the intersecting smaller mains are made with run-arounds fewer valves have to be closed in case of accident than where these connections are made with crosses.

Size of Pipe

Four-inch pipe does not have sufficient carrying capacity to furnish fire protection, and a deficiency is applied in proportion to the percentage of this size of pipe in the system which supplies hydrants. Six-inch pipe is considered the minimum size satisfactory for hydrant supply in residential districts, and only when closely gridironed with cross-connecting mains 6 ins. or larger in diameter at intervals not exceeding 600 ft. Where pressures are lower than about 40 lbs. a satisfactory supply cannot be obtained from 6-in. pipes except where the blocks are small. In high-value districts 8, 10 or 12-in. pipes are required. It frequently happens that although the required quantity of water can be delivered in portions of the high-value district there are other parts where, due to elevation or small pipes, this quantity cannot be obtained: a charge is made for this deficiency.

In the course of development of any system it is impossible to eliminate all dead ends, but 8-in. pipe should be used where dead ends or poor gridironing is likely to exist for some time. A charge is made for dead ends and poor gridironing of 6-in. and smaller pipes, and this charge is reduced in proportion to the pressure carried in excess of 20 lbs., where fire engines are dependent upon and 60 lbs. where direct hydrant hose streams are used.

Cement-lined and wood-stave pipe are unreliable when in a distribution system, and a charge is made in proportion to the length of such pipe or other unreliable pipe found in the system; the danger of electrolytic action is also considered.

In order that hydrants may not be put out of service in too large an area or the carrying capacity of the distribution system seriously reduced, it is necessary to equip the distribution system with a sufficient number of gate valves so located that no single case of accident, breakage or repair to the pipe system will necessitate the shutting from service of a length of pipe greater than 500-ft. in high-value districts, or greater than 800 ft. in other sections, and will not result in shutting down a main artery. All valves should be inspected yearly, and the larger valves more frequently. If valves do not operate in a uniform direction, the spindles should be replaced to secure uniformity.

Hydrants

Hydrants should be of such design that they can deliver 600 gals. a minute with a loss of not more than 2½ lbs., and a loss of not more than 5 lbs. between the street main and the outlet; 4-in. hydrant branches are too small to accomplish this result. All hydrants should have at least two 2½-in. outlets and where engines are used, large suction connections should be provided. Hydrants should be so designed that they will remain closed when broken off; this is of particular importance because of the large number of such accidents dut to the careless driving of motor vehicles. Flush hydrants, particuarly where heavy snows are common are undesirable and cisterns cannot be considered of proper type.

The distribution of hydrants is worthy of thorough study for any deficiency in number or uniformity in distribution prevents the required quantities being concentrated on a fire. Satisfactory distribution requires that two-thirds of the required fire flow be delivered on the fire through hose lines, none exceeding 500 ft. in length when direct hydrant streams are depended upon and none exceeding 600 ft. in length where engines are used. The linear spacing is not the true measure of distribution. This will be readily seen when the size of the block is considered; where blocks are 200 ft. square one hydrant at each street intersection gives an extra area served of 40,000 sq. ft. and a linear spacing of 200 ft., and where blocks are 700 ft. square in order to get one hydrant for each 40,000 sq. ft. it is necessary to set hydrants each 120 ft. along the streets on all sides of each block. From the above it is seen that where hydrant streams are depended upon more hydrants are needed than when engines are used, and in either case, the area served is dependent upon the fire flow required. Where engine streams are used, the areas served per hydrant in square feet for required fire flows in gallons per minute are as follows:

1,000 g. p. m.	120,000 sq. ft.
3,000 g. p. m.	100,000 sq. ft.
5,000 g. p. m.	85,000 sq. ft.
7,500 g. p. m.	65,000 sq. ft.
10,000 g. p. m.	48,000 sq. ft.
12,000 g. p. m.	40,000 sq. ft.

where direct hydrant hose streams are used:

1,000 g. p. m.	100,000 sq. ft.
2,000 g. p. m.	85,000 sq. ft.
3,000 g. p. m.	70,000 sq. ft.
5,000 g. p. m. and over	40,000 sq. ft.

Hydrants should be inspected in the spring and fall of each year, after use at fires during freezing weather, and daily in high value districts during protracted periods of severe cold.

Hydrant branches on large mains should be equipped with a gate valve and where the distribution system is not equipped with sufficient gates to comply with the requirements previously set forth, gates should be installed in the branches served by the smaller mains. It is generally more economical and at the same time is considered better practice to equip the smaller mains within the gridiron of the distribution system with a sufficient number of valves rather than to equip the hydrant branches with gates.

An inspection of the water system enables the percentage deficiency of each part of the works to be determined in respect to the standard and from the percentage thus determined a charge in points is made from a deficiency scale which has been prepared of the points of deficiency corresponding to the per cent. of deficiency. In determining the points of deficiency for any given percentage of deficiency consideration was given to the fact that the seriousness of deficiencies is not so great when the item under consideration is only slightly below the standard and again the value of a seriously deficient item is not proportionately so great as of one less deficient. It is also obvious that the relative values of the items considered in the before enumerated standards are not equal and their importance is properly weighted in points by multiplying the points found in the deficiency scale by a factor corresponding to their importance. For instance, a deficiency in adequacy of capacity of the system to furnish average consumption and fire flow is charged at 2 times deficiency scale while the deficiency to furnish maximum domestic consumption and fire flow is charged at only ½ deficiency scale.

Similar standards have been established to cover fire department, fire alarm and the remaining features of the fire defenses of a city. With these standards established and properly applied in accordance with the schedule the classification can be determined with accuracy approaching that obtained by measuring a distance with a steel tape. In other words, the grading schedule has established a unit of measure by which fire defenses can be surveyed with accurate results. Each of the standards has been described in brief form but with the ideas that the fundamental principles were set forth in such manner that the engineer and superintendent could deduct the interpretations applicable to the particular works under consideration and if these principles are followed, even though the lack of funds may preclude a complete compliance, a more adequate and reliable works will result than if they be disregarded.

THE DETECTION OF LEAKS IN UNDERGROUND WATER PIPES

By H. E. Babbitt, Asst. Prof. Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill.

Locating Leaks by Observation.

The simplest method for location of leaks is by observation, if it can be called a method. It would scarcely seem to take much experience to say "there is a leak" if water is seen bubbling up in a city street. Peculiarly the visual evidence may be sufficient to demonstrate the existence of a leak but its exact location may not be immediately below the point at which the water is appearing. However, the thing to do is to dig at the point where the water is appearing, and if water is found coming in from the side of the hole, the follow along until the leak is reached or to use one of the more simple methods subsequently described. A water works superintendent who observes a luxuriant growth of vegetation along the line of his water pipes in the midst of a hot dry spell is safe assuming that his pipes are leaking nearby and that an appreciable saving can be made by stopping the leak located there. If a sewer or drain pipe is seen to be discharging continuously even during the driest weather, suspicion should be directed to the line of water pipe that the drain crosses as contributing the flow through a leak.

Using Sounding Rods.

Leaks discovered by observation in this fashion may follow along the pipes for some distance before making an appearance. If the leak is not located in the excavation made at the place of appearance, a pointed steel rod about ½ to ⅜ in. in diameter and 5 to 6 ft. long can be driven down to the pipe through most soils. If on withdrawal the rod is found to be moist the indications are that the leak is further upgrade, and on withdrawing the rod in a dry condition the leak has been passed and lies between the last two points of driving the rod. Such a rod is called a sounding rod.

Locating Leaks by Sound.

Sounding rods have no relation to the detection of leaks by sound which is the most common manner in which leaks are located which is worthy of the name "method." The sound caused by a leak from a water pipe is a function of the velocity of flow, the size and condition of the opening, and whether the leak is discharging under water or into the air. A high velocity through a small aperture will make more noise than a large discharge through a large aperture. A free discharge will be more noisy than a submerged discharge. It is a well known law of physics that sound will travel faster and further through a solid body than through gas. If leaking is taking place in a pipe the sound will be transmitted by the pipe for long distances. The sound can be picked up by placing the ear against the pipe or some fixture connected thereto, or better by the assistance of some of the instruments made for the amplification of sound.

The Aquaphone.

The aquaphone, or water phone, is the simplest instrument and the most commonly used. The device consists of a solid metal rod soldered to the center of a thin metal diaphram as used in an ordinary telephone receiver. The point of the rod protrudes from the end of the receiver and is placed in contact with the pipe or fixture. The leak is located by following along the pipe as the sound increases. If the pipe is buried a sounding rod may be driven down to make contact with it. The aquaphone is placed in contact with the sounding rod. Considerable experience is necessary for the successful use of this instrument.

Other Sound Amplifiers

The detectaphone, the sonograph, the sonoscope, the

geophone, etc., are somewhat similar instruments. The volume of sound in some of these instruments is increased by an electrical amplifier placed in line between the point of contact and the receiver. The receiver is similar to the ordinary telephone instrument with electrical coil and magnet. The sound waves set up in the pipe are converted to electrical waves, amplified and transmitted to the receiver, much more loudly and clearly.

It is to be noted that all of the instruments described so far require direct contact with the pipe. This may be a decidedly undesirable feature as the exact location of a leak in a buried pipe may require that excavations be made in order to reach the pipe. The sounding rod does not always work well with the aquaphone.

Darley's Leak Locator

Darley's Leak Locator is a sound detecting instrument that does not require direct contact with the pipe. A very delicate sound detector is set up on a four-legged brass table which rests on the surface of the ground, and is protected from air currents by placing the box containing the electrical cells over it when in use. The vibrations set up in the detector are converted to electric waves which are transmitted through an amplifier to a very sensitive telephone receiver. The instrument is so sensitive that it will detect the sound of a leak through the pavement and the ground at the ordinary depths to which water pipes are buried. The instrument cannot be used in a high wind or where other noises may interfere. Satisfactory results have been obtained with its use.

Utilizing Water Hammer in Locating Leaks

The phenomenon of water hammer is useful in locating a leak in a water pipe. It is well known that if a valve in a pipe line is closed quickly a pressure is set up in the pipe. This pressure is called water hammer. It differs from the effect caused by a blow in that the pressure is maintained for some time. A wave of high pressure travels from the valve up the pipe to a point of relief and a wave of low pressure then returns to the starting point at the valve. The pressure at the valve fluctuates above and below normal until the disturbance has become stilled by the friction of its passage through the pipe, and the pressure returns to normal. Intermediate discharges between the valve and the point of relief will cause fluctuations in the pressure at the valve after the water hammer has been created, and if many of these intermediate discharges exist the fluctuations of pressure will be too confusing to be of value. The speed at which the wave travels is affected by the diameter of the pipe, its material, and other factors and varies between 3,600 and 4,200 ft. per second. In the application of this phenomenon to the location of a leak, the approximate location of the leak should be determined and the line of pipe on which the leak is located should be isolated by closing of valves so that it is connected to only one large service main, preferably much larger than the pipe in question. It may be necessary to shut off service connections or to apply the method at night when the service pipes are not drawing water. A quick shutting valve is attached to a hydrant so located that the leak is between it and the water main. The distance from the hydrant to the connecting main along the pipe line should be measured accurately. A delicate recording pressure gage is attached to another nozzle on the hydrant. The dial is revolved by clock-work. Time is recorded by the vibrations of a tuning fork. After the instruments are connected up and the clock is running, the valve is opened and water allowed to flow from the hydrant. The valve is then closed suddenly. On the closing of the valve the pressure will jump up. The pressure will remain at this height until a slightly relieving wave has returned from the point of the leak when it will drop a little. The pressure will then remain constant until the low pressure wave has returned from the point of relief. The exact location of the leak is then determined by proportional distances from a diagram of the variation in the water pressure.

Use of Chemicals in Locating Leaks

A method requiring the use of chemicals was suggested by T. J. Hoxie in the Journal of the New England Water Works Association, Vol. 27, page 307. The leak is located tentatively within a certain section of pipe which is then isolated. It is essential that all service connections be closed. A corporation cock is tapped into the main somewhere above the leak. To this is connected a 6 to 8 in. length of 2 or 3 in. pipe and a valve. Two or three pounds of caustic soda are inserted in the tube, the large valve closed, and the time of opening of the corporation cock noted. Samples are collected at various points along the line and tested for alkalinity with phenophtalene. As soon as the alkalinity is found at any one point it indicates that there is a leak beyond that point because the flow created by the leak has carried the chemical down. Finally a point will be reached where the alkalinity does not appear. The indication is that the leak is somewhere between this point and the point at which it was last found. Water is withdrawn at the point at which the alkalinity has not appeared and the quantity withdrawn before the alkalinity does appear is carefully measured. This quantity, divided by the volume per unit length of the pipe will give the distance to the leak. Any number of leaks can be detected in this fashion.

Utilizing Volumetric Displacement

An ingenious method based on volumetric displacement was used for the location of a leak in a pipe line during the construction of the Field Museum in Chicago. A piston was made which fitted the inside of the pipe. A Y-branch was inserted in the pipe line, the piston was put in the pipe, through this branch and a cable attached to the piston was passed through a packed joint in the plug closing the Y-branch. The water was then gently turned in the pipe just sufficiently to keep the piston moving. When it had reached the leak it stopped and the length of the cable measured the distance to the leak.

Leak in Submerged Line

A simple method for the location of a leak in a submerged pipe is to dump a quantity of bluing in the line. The appearance of the bluing in the river or harbor will locate the position of the leak. Other equally difficult methods may be as effective as the more scientific methods just described.

Wireless Pipe Locator

If the location of the pipe line itself is unknown there

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is an instrument available known as the wireless pipe locator by which the exact location of the pipe can be determined. This apparatus is manufactured by the H. W. Clark Company of Mattoon, Illinois. An electric circuit is made by connecting two points on the pipe line by an electric wire. A battery and vibrator are put in this circuit, the vibrator serving to interrupt the current rapidly. An induction coil and a detecting coil connected to a telephone receiver are carried in the hand. When the induction coil held in a horizontal position is brought into the vibrating electric field, set up by the electric circuit through the pipe and wire, a singing noise is heard in the telephone receiver. The volume of sound increases until directly over the pipe when it ceases altogether. If the coil is then turned in a vertical position the loudest sound is heard.

The foregoing paper by Prof. Babbitt was presented at the 1920 convention of the Illinois Section of the American Water Works Association.

STRIPPING A SANDPIT BY BLASTING

It has been common practice for years to use dynamite for stripping top soil from iron ore beds, shallow coal deposits, stone quarries, etc., but it is unusual to blast the top soil from sand and gravel pits; yet the method is equally applicable to such work and saves as much time and labor in the one as the others.

A description of the method employed by the Washington Sand and Gravel Company at their works near Bladenburg, Maryland, may be of interest to other producers of these materials.

The pits are located at the side of a creek or small river. The sand is loaded on boats by means of a floating suction dredge operated on the creek. To get at the sand, it is necessary to strip off 4 to 6 ft. of top soil. This stripping is now done by blasting with dynamite. A shot recently observed was loaded as follows:

Bore holes were put down vertically, 4 ft. deep and located 8 ft. back from the creek bank. In this shot, there were seven charged holes, 2½ ft. apart in the row. Five cartridges of 40 per cent. ammonia dynamite 1⅛ x 8 was the charge in each hole. Each charge was primed with an electric blasting cap and the firing done with a blasting machine. The shot removed the top from the section blasted, throwing most of the dirt into the creek.

It is figured that the cost of the blasting is more than balanced by the saving in the time and cost of operating the dredge to remove the top. This work was all waste, because no use could be made of the top soil.

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Water Cleaning System if you wish it, or Drag Bucket type.

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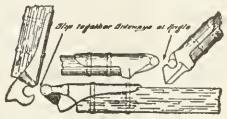

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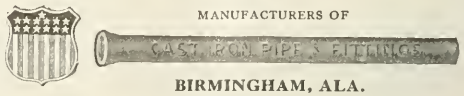

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Construction News and Equipment

CENTRAL MIXING PLANT MAKES NEW PAVING RECORD AT BIG LAKE, MINN.

(Editor's Note—Since the following article was written the record therein described has been broken on the same job. The contractors report a run of 1,094 ft. on this 18-ft. road, 7 ins. thick, in eight hours. They are not yet fully equipped with trucks and so cannot handle the mixed concrete to the full capacity of the mixer. When they get their 12 trucks with dump bodies running they expect to raise their record to over 1,200 ft. of finished pavement in eight hours).

Where conditions warrant the use of a "central mixing plant" for paving work, it has usually been contended that this method is exceptionally speedy. It is interesting to note, therefore, that a new world's record for a single day's production has been established by McCree, Moos & Co., St. Paul highway contractors, using a 1-yd. Smith Tilting Mixer, operated as a central mixing plant.

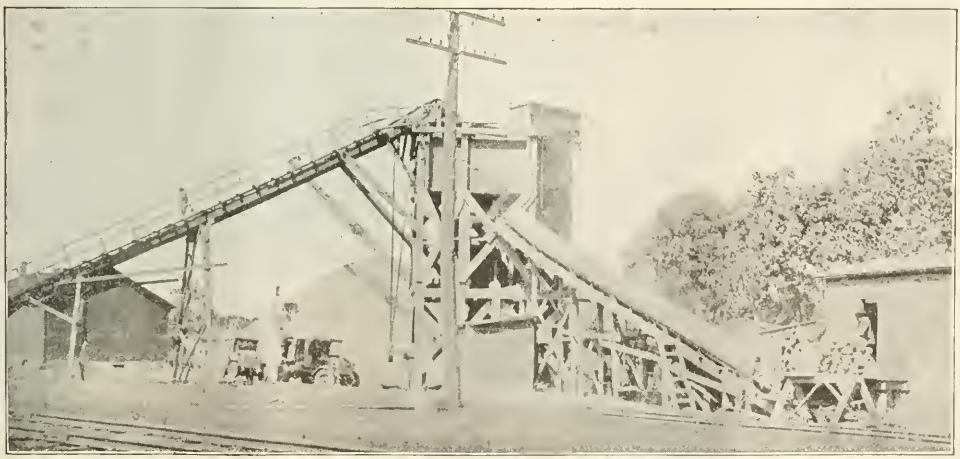
The total yardage laid by the central mixing plant in 10 hours was 355 cu. yds., the record day's production being 912 lin. ft. of 18-ft. road, average thickness 7 ins. The world's record using the paving mixer method, as established by Alan Jay Parrish at Paris, Ill., was 308 cu. yds., the record production for 10 hours being 779 lin. ft. of 8-in., 16-ft. road.

By these records, the central mixing plant method produced over 15 per cent. more road than the paving mixer method. State specifications on both jobs required a full minute mix per batch.

The details contributing to this 912 ft. record are worthy of careful study. The McCree, Moos contract covers 7½ miles of road running north and south from Big Lake, Minn. The central mixing plant was located in Big Lake at the half-way point of this road so that the maximum haul for the mixed concrete to either extremity of the road was 3¾ miles.

CONCRETE DELIVERED TO ROAD BY TRUCK, SPREAD BY HORSE-DRAWN SCRAPERS BETWEEN HELTZEL STEEL FORMS, TAMPED AND FINISHED BY MACHINE.

It is an 18-ft. highway, one course concrete pavement, 6½ ins. thick on the sides and 7½ ins. thick in the center, the average thickness being termed 7 ins. A 1-2-4 mix was used, as allowed by the State of Minnesota when a machine tamper and finisher is used. The State specifications on "composition" are as follows: "This concrete shall be composed of 1 part Portland Cement, 2 parts fine aggregate and 3½ parts of coarse aggregate unless the machine tamper and finisher is used, in which



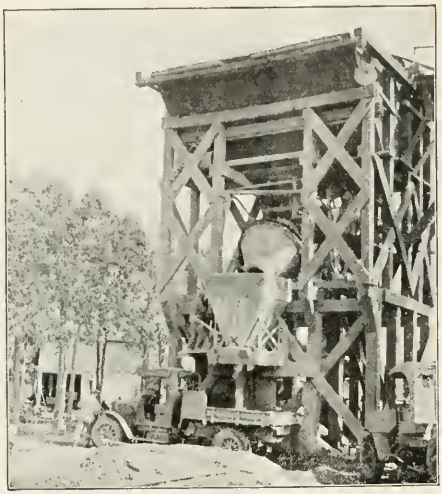
CENTRAL MIXING PLANT ON BIG LAKE, MINN., ROAD CONSTRUCTION JOB, ILLUSTRATING SIMPLE METHOD OF LOADING HOPPERS WITH SAND, CEMENT AND STONE.

Printed as insert to MUNICIPAL AND COUNTY ENGINEERING, Chicago, Ill., November, 1920.

case 4 parts of coarse aggregate may be used."

The State's clause specifying "consistency" reads as follows:

"Sufficient water shall be used in mixing to produce a concrete which will meet with the following test: When



SMITH TILTING MIXER DISCHARGING INTO TRUCK WITH ORDINARY DUMP BODY, AT CENTRAL MIXING PLANT.

placed and tamped in a cylinder 6 ins. in diameter and 12 ins. high and the form removed, the concrete shall have a vertical settlement of not more than 2 ins. when machine finishing is employed and not more than 6 ins. when hand finishing is employed."

The dry mix was necessary, therefore, on this job and the central mixing plant proved its practicability thoroughly even with this mix.

The clause specifying "Mixing" reads as follows: "Concrete shall be mixed to designate consistency in a batch concrete mixer of the approved type until the cement is uniformly distributed and the concrete is homogeneous and uniform in color. Each batch shall remain in the mixer at least one minute and have not less than 12 nor more than 18 full turns of the mixing drum. The mixers shall be equipped with a timing device. Retempering or remixing concrete that is partially hardened will not be permitted."

A full minute mix was strictly used. McCree, Moos & Company had a batch meter of their own make on this Tilting Mixer which merely rang a bell at the end of the required number of revolutions of the drum, but which did not register these revolutions. The State Highway Engineer permitted them to use this batch meter instead of one furnished on the Smith mixer.

The handling of materials at the central mixing plant is very efficiently and simply arranged. The cement, in bags, is unloaded direct from the cars into a warehouse at the plant. A belt conveyor leads from the warehouse to a hopper directly over the mixer. The bags are opened in the warehouse and the cement, six bags at a time—enough for one batch—is dumped upon the belt conveyor which carries it up to the cement hopper.

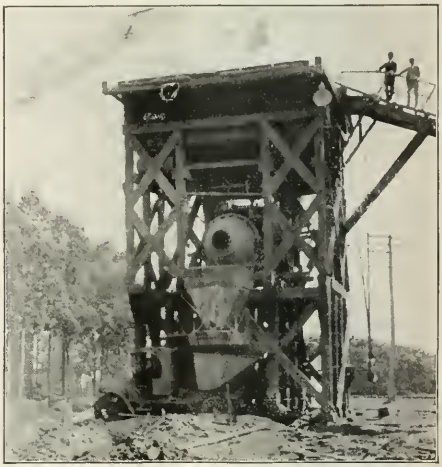
The sand is brought from a pit 1¾ miles away to the central mixing plant, by 2½-ton end-dump trucks with Lee bodies. The trucks deposit the sand into a trap, from which another belt conveyor elevates it to a second hopper over the mixer. This sand hopper has a capacity of 20 yds.

The crushed stone is St. Cloud granite and is shipped to the plant in gondolas. A 1-yd. clam shell bucket on an 85-ft. boom derrick unloads from these cars directly into a third hopper over the mixer. The stone hopper has a capacity of 25 yds. When filled, the surplus crushed stone is unloaded into a stock pile behind the derrick and then the hopper is kept supplied from this stock pile.

The batch hopper of the mixer is subdivided to hold the correct proportions of cement, sand and crushed stone, which are fed into the batch hopper from the respective material hoppers directly above it.

After the one minute mix the mixer tilts and discharges its entire batch in 8 seconds into a bottom dump hopper arranged just high enough to permit the trucks to drive in beneath it. This hopper for the mixed concrete will hold two full batches, 2 cu. yds.

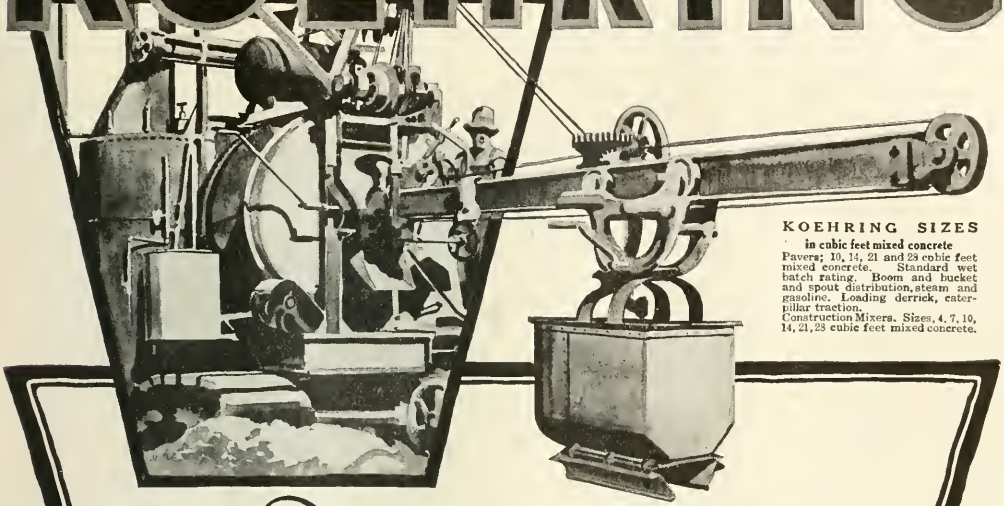
The wet concrete is carried to the road by motor trucks, 2½-ton capacity, special short wheelbase, equipped with end-dump bodies manufactured by the Lee Loader & Body Co., Chicago. These bodies have a level capacity of 2 yds., but are usually loaded with about 1½ yds. of concrete. The contractors are using 3,000 ft. of Type L 6 in. Heltzel Standard Road Forms on this job.



TRUCK WITH LEE BODY READY FOR A LOAD OF MIXED CONCRETE AT CENTRAL MIXING PLANT.

The first stretch of road laid on this contract was started a mile and a half north of the mixing plant, working south. When this section had been completed up to the mixing plant, the work was started a mile and a half south of the town of Big Lake, working north. When this three mile section was completed and ready for traffic, the work was started at the extreme northern extremity of the road, 3¾ miles from the mixing plant,

KOEHRING



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Construction Mixers. Sizes, 4, 7, 10, 14, 21, 28 cubic feet mixed concrete.

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Fastest, easiest controlled discharge because of discharge chute pivoted inside the drum, and arrangement of blades and pick-up buckets.

All these features combined into the fastest paving unit by Koehring exclusive automatic actions which enable operator to maintain day-long, top speed operation—and all supported by the Koehring Heavy Duty Constuction.

Fastest distribution of any consistency of concrete to sub-grade because of Koehring boom and bucket distributing system, the greatest distributing range without moving the mixer.

Write for Mixer catalogue and Mixer Loader catalogue.

Mechanical Loading

Loading derricks to lift batch boxes from cars or trucks to charging skip. Koehring Mixer Loader when materials are placed on sub-grade cuts out all wheelers.

Koehring Machine Company
Milwaukee Wisconsin

working south again. This system enables the trucks to travel a mile and a half over the new concrete road with their loads of concrete and continually cuts down the stretch that has to be traveled over the unpaved road.

One of the interesting points about this job is that the 912-ft. record is not at all indicative of the real capacity of this central mixing plant. The amount of pavement laid depended entirely upon the transportation facilities for the concrete. Not nearly enough trucks were equipped with the Lee bodies to work the plant to its full capacity.

More trucks are required, of course, when the haul is to the extremities of the road than when paving near the mixing plant. For instance, on the first mile and a half, while paving not more than half a mile from the plant, with only four trucks they succeeded in laying 883 lin. ft. in one day. Then, with seven trucks, paving the section at the furthest extremity of the road, they made their 912-ft. record in one day. If they had had their complete fleet of 12 trucks available for this work the record could have been far greater as the mixing plant had to wait repeatedly for the trucks to handle the concrete.

On this job, McCree, Moos & Company have made the remarkable average daily record of 1,100 sq. yds. or 550 lin. ft., for several weeks on this 7-in., 18-ft. highway.

DUMPING MIXED CONCRETE FROM ORDINARY MOTOR TRUCK WITH DUMP BODY.

The history of the old Tilting Smith Mixer used on this job is interesting. It is a "second-hand" mixer, sold originally by the T. L. Smith Co., Chicago, to A. Guthrie & Co., Blue Island, Ill., in 1916. It was used on the big project of the Calumet Sag Channel at Blue Island and was finally resold to McCree, Moos & Company after that job was completed. Originally it was equipped with electric motor but was resold without the motor. On the present job, a motor is mounted near the ground and the power is transmitted by a long belt to the mixer up on the scaffold. With the exception of this new motor, the old Smith Tilting Mixer is just as it was originally in 1916, including the batch hopper and all.

The belt conveyors are also "second-hand" equipment, but the records of production prove that the work is being accomplished in a first-class manner.

Comparing the two methods of paving—the paving mixer method and the central mixing plant method—the total yardage speaks favorably for the central mixing plant. Considering, however, that the paving mixer had a ¾-yd. mixed concrete capacity and was working with

THE LEE END-DUMP BODIES DISCHARGE QUICKLY AND COMPLETELY.

a 1-2-3-½ batch instead of a 1-2-4 batch, (shrinkage being somewhat more on the 1-2-3-½ mix), the percentage of increase of the central plant over the paving mixer is somewhat minimized. On the other hand, the central plant in this case was somewhat handicapped by insufficient transportation of the mixed concrete.

It is certain, however, that both methods have been successfully employed and it is important that conditions on every paving job should be carefully studied in order to determine which of the two methods is the more practicable and profitable under the existing conditions.

NEW ALL-MULTIPEDAL TRENCHING MACHINE CLIMBS CURBS AND CROSSES SIDEWALKS TO DIG HOUSE CONNECTION TRENCHES

A new type of trenching machine, now being placed on the market, and here illustrated, is designed to turn practically within its own radius. It has full multipedal traction and is strictly a "one-man" machine.

The full multipedal traction steers through heavy friction clutches—one on each side—its action in this respect being similar to the military tank. It is of sufficiently light weight to handle efficiently trenches or house connections, sewers, etc. The machine will cross sidewalks, climb over a curb, cross bridges, and travel over any and all types of pavements, thereby reducing to a minimum the danger or damage claims.

Its road traction speed is higher than that of ordinary trenching machines.

A screw hoist raises and lowers the digging arm automatically, and the endless chain and buckets are of standard type. This screw hoist also acts effectively, because of its construction, as a lever to force the buckets to dig, by crowding the bucket line against the face of the ditch or cut.

A cleaning device takes care of the sticky dirt, and

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Throughout all work of telephone construction and operation there is a ceaseless endeavor at mastery of service that makes for improvements beneficial to the public.

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scrapes out each bucket as it passes a point at the head of the excavator boom, directly over the conveyor belt. This can be adjusted to deliver the excavated material to either side of the machine.

Strength and weight have not been sacrificed in order to secure a short-based, mobile and very speedy digger, thereby keeping it in the already well-known family of Austin trenching machines.

The illustration shows this new All-Multipedal Austin machine at work on trench excavation.

The gasoline engine is of 4 cylinder cycle type, cooled by an enclosed radiator.

Some of the details which are of interest to sewer, water, gas, electric and oil pipe line contractors and corporations are as follows:

The digging width, with 18-in. buckets, will run from 20 ins. to 28½ ins., and with 24-in. buckets, from 26½ ins. to 29 ins. The standard boom will dig up to 6 ft. in with an extensive equipment for digging 8 ft. deep. The traction accommodates itself to irregular surfaces, as the equipment consists of two oscillating multipedals. Each depth, although the machine is substantial for service

THE AUSTIN ALL-MULTIPEDAL TRENCHING MACHINE IN OPERATION.

one of these multipedal tractions is driven independently of the other by a friction clutch, so that in turning in a confined space, one may be stopped while the other is going ahead, turning the machine practically within its own length.

The digging speed naturally depends upon conditions of the soil and the depth of trench, but the machine will dig at a phenomenal rate of speed.

The conveyor belt is reversible, so that it can deliver dirt on either side. Adjustable screws are provided for taking up the slack.

The power and mobility of this machine, and its extreme flexibility, will enable the operator to do work in many places where the ordinary machine cannot go at all, and at the present it is the only All-Multipedal traction trenching machine built.

An important feature of the working performance is its ready interchangeability for digging trenches with vertical banks or small ditches with sloping sides.

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Grading

Little need be said concerning the building of the earth road before the gravel was applied; a brief description will suffice. Beginning at the north end of the project,

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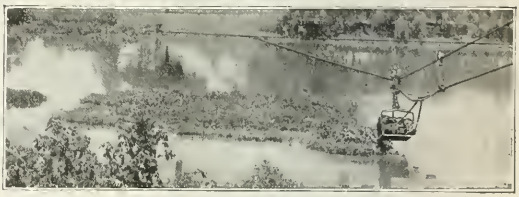

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The ability of the Sauerman Dragline Cableway Excavator to dig from either above or below water, and to elevate and convey materials from pit to plant without the help of auxiliary machinery, is the reason for its popularity among sand and gravel producers. This same ability makes our type of equipment correspondingly economical and efficient for a wide variety of other material-handling operations, and it is now being successfully used for cleaning reservoirs, building levees, rehandling coal, deepening rivers, reclaiming material from stock piles, loading ballast, etc., etc.

For further information send for our catalog, or lay the details of your problem before us and we will submit our recommendations on equipment.

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SAVES CAR DEMURRAGE

ELIMINATES SHOVEL AND WHEELBARROW WORK
KEEPS EQUIPMENT MOVING

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PORTABLE MACHINERY CO., PASSAIC N.J.

which is 33 miles long, the road from the end of the Fremont bridge on— a distance of three miles, contains considerable heavy cut and fill. Then follows 14 miles of comparatively level road, with no excavation beyond the ordinary ditch cut made necessary in grading the road. The next 5 miles are rolling and the last 6 miles partly rolling and partly level. The construction is in no

EQUIPMENT USED IN BUILDING FREMONT-CERESCO, NEBRASKA, ROAD AND VIEW OF PIT FROM WHICH GRAVEL IS EXCAVATED FOR SURFACING THE ROAD.

way unusual nor remarkable, with the exception of several heavy cuts at the beginning of the project and an especially large culvert, 175 ft. long. About 6 miles of the total 33 miles were completed March 27, 1920, and the entire earth work completed Aug. 2, 1920.

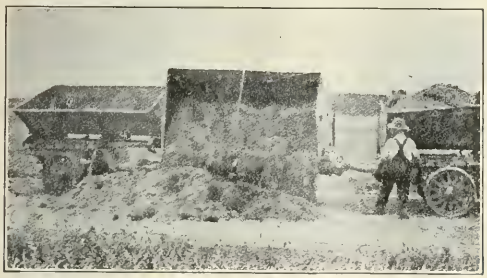
Equipment

The contractor's force consisted of one tractor and one horse drawn outfit, with the following equipment:

2 Foremen	2 Blade Graders
2 Stablemen	1 Holt Tractor (10 Ton)
1 Blacksmith	
1 Engineer	2 Elevator Grades
2 Plowholders	1 Tractor 1 Horse Drawn
1 Machine Driver	27 Teams
1 Timekeeper	2 Mormons
14 Wagons	20 Men

Use of Motor Trucks

When the work of graveling the road was started, the gravel was hauled in army trucks, allotted to the State by the Government. These trucks were equipped with



DUMPING GRAVEL ON THE FREMONT-CERESCO, NEBRASKA, ROAD.

dump bodies, and hauled an average of 2¼ cu. yds. per load. The gravel was excavated from a bank pit, with an auto crane, equipped with clam-shell bucket. Later it was deemed advisable to discontinue the trucks, and use Troy trailers in a train of from 8 to 10, capacity approximately

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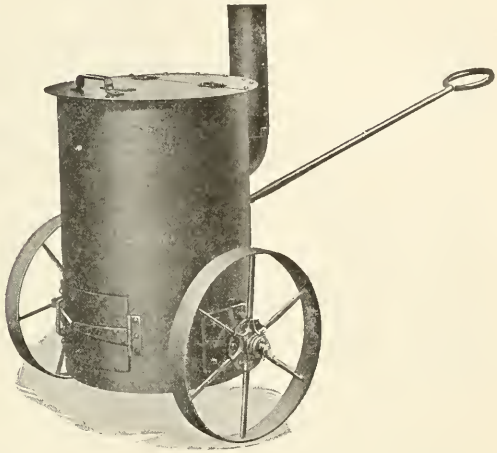

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with their present day vehicular traffic, demand constant inspection and immediate attention when the surface shows signs of wear. Efficient systems of highway patroling have resulted.

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4 yds. The size of the load was governed by the condition of the road, and the steepness or rutty condition of the surface. Trailers were purchased, and the work is being done with comparative ease and rapidity.

Gravel Spread in Two Courses

One of the most important facts developed during construction was that the gravel must be spread in two courses of 2 ins. each, thereby enabling the first course to rut into the surface of the road, and become thoroughly compacted before the second course was applied. By this method, a more compacted and smoother surface resulted than could possibly have been secured by applying one 4-in. course at a time.

Constant dragging is necessary with this type of surfacing, and especially during the time the road is compacting. An abundance of rain will also aid the process and insure a smoother surface. The traffic ruts in the gravel, but continues only for a short time, for as it dries the rutting ceases and the road surface commences to smooth out under the general traffic, and the care that is given it at this time, of dragging and blading. The traffic is as essential as the periodic dragging, and the one assists the other.

Not Merely a Surfacing Process

It must be remembered that this type of gravel road is not merely a surfacing process, for the earth road bed must be well compacted and thoroughly drained before the gravel is spread. Promiscuous spreading of gravel on roads that apparently have a good surface is not warranted. The crown should be 6 ins. with a 24-ft. roadway, and in such condition that it will support traffic. The gravel provides the wearing surface and in addition keeps the subgrade dry, as the gravel by reason of the clay and iron oxide contained in it, is more or less impervious to water, much more so than the best of well compacted earth road beds.

There are several gravel projects at present in Nebraska, located at Wood River, Grand Island and North Platte-Sutherland. If the latest request from the Federal Government is compiled with, it will mean that hereafter, projects will not be approved unless there is an adequate and substantial type of surfacing promised for every Federal Aid road in a reasonable time after the initial improvement of the project. In short, the time is coming when this State will of necessity, provide a substantial surface for the Federal roads, and in all probability, since there is an abundant supply of gravel in the State, a large share of these roads will be graveled.

At present this type of surfacing is being watched closely by engineers, road enthusiasts, and the general public, for it may yet prove to be Nebraska's cheapest and best type of surfacing for the State Highway System.

LOADING AND SCREENING WITH A SCOOP CONVEYOR

The accompanying illustration shows a novel Scoop Conveyor installation at the sand pit of Somers & Sons, Wyoming, Pa. Mr. Somers had been experiencing much trouble and expense in screening his sand and, being a resourceful man, it occurred to him that an arrangement could be made with his Scoop Conveyor so as to screen while loading. The arrangement illustrated was adopted. The screen was placed in the truck and supported by a pole and, on the edge of the truck, by a small block of wood.

The 24-ft. Scoop Conveyor was then placed so that the material, when discharged, would fall near the top of the

NOVEL SCOOP CONVEYOR INSTALLATION AT A SAND PIT.

screen. The screen being set at the proper angle the large lumps rolled off out of the truck while the fines fell through.

With this arrangement Mr. Somers is loading and screening tons of sand in 7 minutes. In addition to the money saved on the loading operation the additional revenue obtained by delivering screened sand made this an investment that soon paid for itself.

AUSTIN EXPANSION BENEFITS CONTRACTORS

Difficulty in obtaining necessary equipment last year interfered with the improvement plans of cities and counties everywhere. The concerns and individuals who are responsible for the conversion of huge appropriations for road building, irrigation projects, building excavations and kindred developments, needed a powerful ally in overcoming this obstacle.

To make its comprehensive line of paving, trench-digging and concrete-mixing machinery immediately available to contractors, thus assuring them that any contract-obligations they may assume will be fulfilled to the letter, the Austin Machinery Corporation reports the establishment of ten primary district offices and warehouses and upwards of fifty subsidiary offices and agencies throughout the United States.

It is the purpose of this corporation to place every contractor, city engineer, public works director and official, and other user of road-building and sewer and water-pipe trench-digging machinery in the United States in close proximity to a branch of the organization in charge of experienced representatives capable of rendering efficient service, to the end that they may order any required machines and parts with full assurance that they will be delivered at the stations nearest their first jobs on or before the date specified to begin operations.

The cities at which the district offices and warehouses are located were selected with a view of affording the most strategic positions from point of trunk-line shipment. Each warehouse carries a full stock of machines

and parts. Their large manufacturing plants are in full production. The needs of foreign countries, as well as domestic requirements, are provided for.

The organization plan by which this was accomplished was so comprehensive and so thoroughly worked out that all types of Austin machines soon will be available, on short notice, anywhere in the United States and in a large section of Canada.

The full significance of this achievement becomes apparent with a realization of the fact that the Austin Machinery Corporation is the largest manufacturer of the most comprehensive line of earth-moving and concrete-mixing and handling machinery in the world.

GREAT EXHIBITION OF HIGHWAY MACHINERY AND MATERIALS

Representatives of fifteen industries identified with highway construction held a meeting at The Automobile Club of America October 22, 1920, the purpose of the meeting being to complete the organization of an advisory committee of manufacturers to co-operate with the American Road Builders' Association in holding a great exposition of highway equipment and materials in connection with the Association's annual convention, which will be held at The Coliseum, Chicago, during the week of February 7, 1921.

The industries represented at the forthcoming exposition will include the sand and gravel industry; crushed stone; Portland cement; asphalt and oil; tar; granite block; paving brick; slag; road building machinery; quarrying machinery; excavating machinery; trucks, tractors and trailers; concrete mixers; engineering instruments and explosives. It was developed at the meeting that upwards of one billion dollars is annually available for highway and street work and that a genuine necessity exists for capacity production and distribution of highway materials and equipment.

An Executive Committee to represent the producers and manufacturers was appointed, consisting of J. E. Pennybacker, of The Asphalt Association; B. H. Wait, of the Portland Cement Association; W. T. Chollar, of the Lakewood Engineering Company; D. C. Fenner, of the International Motor Truck Company, and P. P. Sharples, of The Barrett Company. A Chicago Committee was also appointed, with S. F. Beatty, of the Austin-Western Road Machinery Company, as Chairman.

CONTRACTS AWARDED

ROADS AND STREETS.

Ark., Star City—General Constr. Co., Little Rock, Ark., awarded contract to construct 13 miles gravel road, at $325,000.

Ala., Decatur—A. B. Howard & Co., 148 Fourth Ave., N., Nashville, Tenn., awarded contract for grading, draining and surfacing 9.17 mi. State Trunk Rd.—Albany to Hartsells—at $61,742.

Ala., Florence—Wm. T. Taylor Constr. Co., Sylacauga, Ala., awarded contract by State Hwy. Comm., Montgomery, to construct 12 miles of road in Lauderdale Co., at $156,885.

Ariz., Phoenix—State Hwy. Dept., Phoenix, awarded contract to M. Ryan, 935 Bway., San Diego, Cal., at $143,112, for gravel surfacing 8.6645 miles Sec. D, Florence Superior Hwy., F. A. Proj. 23, involving 46,430 cu. yds. unclassified excav. in rdway, cost $1.65 per cu. yd., 20,760 unclassified borrow excav., etc., etc., at total cost of $177,031.

Ariz., Florence—Jack Davey, Superior, awarded contract for constr. of 10,058 sq. yds. concrete pavement thru town of Ray, at $52,834.

Cal., Fresno—California Constr. Co. awarded contr. for paving with asph. conc., Route 3, Secs. A and B Madera Avenue, 7.223 miles, at $174,142.

Cal., Fresno—California Constr. Co. awarded contract for paving Sec. A, Routes 16, 22, 23, 24, 29 and 30, and part of Route 18, Sec. A and Route 20, Sec. B county hwy. (Fowler-Selma-Kingsburg Rd.) at $507,572.

Cal., San Francisco—Schultz Constr. Co. awarded contract for Market Street extension work at $97,192. Wk. includes grading, laying sewer and bldg. conc. retaining walls.

Cal., Stockton—C. Moreing, Stockton, awarded contrs. for grading Hammer Lane and Upper Copperopolis Rd., at $48,075 and $63,919, respectively; Waterloo Rd., to F. E. Brooks, Stockton, at $30,096.

Cal., Stockton—J. E. Johnston, Tracy, awarded contr. for grading and paving Walnut Street and others, with bitum. pavement and constructing cement curb, walks and gutters, at $56,954.

Ga., Decatur—Kreis & Wardrep, Knoxville, Tenn., awarded contr. to construct 1.913 miles National Hwy. betw. Decatur and Scottdale, at $750,000.

Ga., Rome—J. W. Stapp Constr. Co., Louisville, Ala., awarded contr. to construct 7 miles soil-surfaced roadway, $65,000 available.

Ill., Murphysboro—Bius & Olsen, St. Joseph, Mo., awarded contr. for constr. of 2 sections from Anna to Ullin, at $223,000; Ullin to Pulaski, at $71,920.

Ill., Springfield—Following contracts let for road construction: Goggin Constr. Co., Arcola, Ill., contr. for Sec. 2A, Henry Co., at $63,552; E. A. Lord Constr. Co., Monmouth, Ill., contr. for project 20, Sec. 6A, 7A, 8A, Henry and Bureau Cos., at $58,900; Gund-Graham Co., Freeport, Ill., contr. for project 20, Sect. 10A and 11A, Henry and Bureau Cos., at $19,906; Keokuk County & Constr. Co., Keokuk, Iowa, project 21, Sec. 2A, Warren Co., at $22,997; Shidler Constr. and Material Co., Kankakee, Ill., contr. for project 22, Sec. 1A, Kankakee Co., at $7,450; Hamilton Bros., Carbondale, Ill., project 14, Sec. 3A, Jackson Co., at $33,130; A. M. Woolan, 607 Wainwright Bldg., St. Louis, Mo., for project 14, Sec. 23A, and project 9W, Fayette County, at $171,400.

Ill., Springfield—Following contracts let by Dept. Pub. Wks.: Buis & Olson, St. Joseph, Mo., grading Sec. 13A Union Co. and Sec. 14A, Union and Pulaski Cos., both Fed. Aid Proj. 14, $223,000; Sec. 15A, F. A. Proj. 14, Pulaski Co., $71,920; Cameron, Joyce & Co., Keokuk, Iowa, Sec. 16A, F. A. Proj. 14, Pulaski Co., $70,628; M. Hayes & Son, Janesville, Wis., Sec. 2A, F. A. Proj. 18, Champaign Co., $11,716.

Ind., Ft. Wayne—J. C. O'Conner & Son, 2440 Hoagland Ave., awarded contract for grading, draining and paving 7,837 ft. Pontiac St. and Beuter Rd., 18-24 ft. wide, concrete, at $144,039; Grace Constr. and Supply Co., 221 Utility Bldg., awarded contracts for grading, draining, curbing and paving 356 ft. Cherry St., 26 ft. wide, 588 ft. Comparet St., 26 ft. wide, 455 ft. Howell St., 24 ft. wide and 942 ft. State Blvd., 24 ft. wide, at $38,929.

Ind., Indianapolis—Sheehan Constr. Co. awarded contr. for impvt. of Northwestern Ave. Rd., at $154,000.

Ia., Clinton—Koss Constr. Co., 2818 5th St., Des Moines, awarded contract for paving 18 miles of Lincoln Hwy., at $47,900 per mile.

Ky., Henderson—Hopkins Co. Constr. & Engr. Co., Madisonville, Ky., awarded contract to construct 4½ miles of road, at $36,-023; also contract for 9 mi. Madisonville-Hopkins Rd., at $96,161; J. C. Williams, Winchester, Ky., awarded contract for 10 mile Madisonville-Dixon Rd., at $136,676.

Ky., Whitesburg—Letcher Co. Commrs. let contracts to construct 4 mi. earth rd., Whitesburg to Hindman Hwy., 100,000 cu. yds. excav., at $80,000, to Hale & Hall, Whitesburg, Sec. 1; T. R. Rainero, Seco, Ky., Sec. 2.

La., Covington—Bonnabel Constr. Co. awarded contract for constr. of state highway betw. Slidell and Pearl River, at $83,-239.

La., Vidalia—Junkins Bros. & Gregory awarded contract to construct 12 miles of road, at $98,342.

Md., Leonardtown—Ernest H. Schmidt, 2226 Garrison Ave., Balitmore, awarded contract to construct 5 miles State Hwy. from Morganza toward Colton; gravel; St. Marys Co., Contr. SM-14, at $70,429.

Mass., Boston—J. W. O'Connell, Radcliffe Rd., Brighton, awarded contract by Dept. Pub. Wks. for paving Mt. Vernon St., asphalt, at abt. $25,000; B. E. Grant, 27 School St., awarded contract by City for relaying granite blk. pavement on Friend, Richmond and Portland Sts., at $87,300; M. De Matteo, 154 Dudley St., Roslindale, awarded contr. for paving with asph. Arbutus St., Dorchester, at $13,100.

Mass., Brighton P. O., Boston—Simpson Bros., Corp., 77 Summer St., Boston, awarded contract for paving Market and Arlington Sts., asph., at $97,742.

Miss., Natchez—F. D. Harvey & Co., Memphis, Tenn., awarded contr. for Adams Link of Prentiss Hwy. Est. cost, $248,000.

N. J., Newark—Essex County let contracts for impvt. of Franklin Ave., Belleville and Nutley, to Osborn & Marsellis, Belleville Ave., Montclair, at $41,344 and $21,406 respectively; John and Rutgers Sts., Belleville, Belleville Ave., Glen Ridge and Holler Pkway, Newark, to Northern Constr. Co., 75 Montgomery St., Jersey City, at $152,000, $27,663, $155,067 and $30,-130 respectively; Chancellor Ave., in So. Orange and Irvington to Standard Bitulithic Co., 50 Church St., New York City, at $15,700 and $204,480 respectively.

N. Y., Brooklyn—Boro. Pres. Riegelmann let contract for regulating & repaving Kingsland Ave. to Grocco Bros., 172 Russell St., at $29,674; 7th Ave. to Brooklyn Alcatraz Asphalt Co., 407 Hamilton Ave., at $7,463; 58th St. to T. E. McCormick, 810 Lincoln Rd., Flatbush, at $20,353; restoring & repairing where directed, to Sicilian Asphalt Paving Co., 41 Park Row, N. Y. City, at $173,740.

N. Y., St. George, S. I.—C. D. Van Name, Pres. Richmond Boro., let following contracts: repaving with conc. Arthur Kill Rd., Fosters to Woodrows Rd., and from Sharrots to Foster Rds., to W. P. McDonald, Port Richmond, at $163,120 and $165,071 respectively; from Woodrow to Richmond Rd., to J. Donovan, 2205 Richmond Ter., Pt. Richmond, at $164,042; from Bentley St. to Sharrots Rd., to J. Johnson Son, West New Brighton, at $214,487.

N. C., Franklin—Wright & Nave, Asheville, N. C., awarded contract to construct 20.9 miles Three States Natl. Forest Rd., graded, 16 ft. wide, project within Natajala Forest, Rabun, Ga., Macon, N. C., and Oconee, S. C., Counties. $216,000 available.

N. C., Raleigh—Southern Dray Co., Asheville, awarded contract for bldg. 7 miles State Aid Project 100A and 7 miles Proj. 100B, Western N. C. Hwy., Avery Co., waterbound macadam, and 2½ miles gravel road, Madison Co., at $158,000, $124,000 and $75,000 respectively.

O., Cleveland—Gould & Maybock, 823 E. 160th St., awarded contr. for grading, draining and paving E. 14th St., St. Clair to Aspinwall Aves., brick, at $88,513.

Okla., Lawton—Allen & Harrison, Henryetta, awarded contract for rd. work, F. A. Proj. 22, at $73,481.

Ore., Enterprise—Northern Pacific Constr. Co. awarded contract for 4 miles of grading at $326,000.

Ore., Portland—Scandia Shipbldg. Co., Marshfield, awarded contr. for paving Pacific Hwy. betw. Multnomah Co. line and west end of suspension bridge at Oregon City, approx. 6.5 miles, at $220,712. Rd. will be paved with concrete; Washburn & Hall, Broadway Bldg., Portland, awarded contract for road—Wren to Blodgett—Cornwallis-Portland Hwy., at $27,917; J. W. Hilstrom, contr. for Rocking Brush Creek, Hubbard-Creek sect. Coast Hwy., at $25,-900; Porter & Connelly, Railway Exch. Bldg., Portland, awarded contract for grading and rocking Lawen to Crane Rd., Harney Co., at $147,365.

Ore., Salem—Following contracts let by State Hwy. Comm.: gravel surfacing 4.94 mi. McMinnville-West Dayton Sec., West Side Hwy., Yamhill Co., to E. A. Palmer, Lafayette, at $24,395; 9.36 mi. Butte Creek Sec. Jno. Day River Hwy., Wheeler Co., to Blake-Compton Co., McMinnville, at $74,-160; 4.55 mi. Cole Bridge-Danby Ranch Sect. John Day River Hwy., Grant Co., to J. Ross, Prairie City, at $26,960; grading and gravel surfacing 7.86 mi. Haines-North Powder Sec. Old Oregon Trail Hwy., Baker Co., to Oxman & Harrington, Baker, at $99,340.

Pa., Beaver Falls—H. Kirker Co., local, award. contr. for paving First Ave., 8th Ave., 9th, 14th, 15th, 17th Sts., at $170,000.

Pa., Harrisburg—S. Gamble, Carnegie, Pa., awarded contract for bldg. 34,837 ft. one-course rein. conc. roadway on Route 115, Washington Co., at $475,646.

Pa., Philadelphia—Contracts for grading and paving streets costing about $700,000 awarded by Director F. H. Caven. Barber Asphalt Co. and Eastern Paving Co. awarded the bulk of the contracts, although Mack Pavg. & Constr. Co. received one contract for $6,300. Grading work will cover abt. 2 miles of streets, while the paving will take care of approx. 4½ miles (57 blocks).

S. C., Anderson—Phillips & Newell awarded contract by Anderson Co. Hwy. Comm. to construct 8.414 miles Belton-Anderson Rd.; bridges; 54,000 cu. yds. grading; 35,000 cu. yds. top-soil. $80,000 available.

Tex., Highland Park (P. O. Dallas)—Uvalde Paving Co., Dallas, award. contract to pave Lexington and Gillon Aves. $110,-000 available.

Tex., Paris—Smith Bros. & Healy Constr. Co., Dallas, awarded contr. to grade 23 miles Hwy. No. 5, and 25 miles Hwy. No. 19, at $132,000; A. D. McLain Co., Houston awarded contract for conc. draing. structs. at $135,000.

Tex., San Antonio—Southwest Bitulithic Co., 711 Gunter Bldg., awarded contract to pave Camp, Burleson, Cherry, Travis and other streets and avenues, at $289,800.

Tex., Ft. Worth—W. P. McCoy, Ft. Worth, awarded contract for grading and constructing draing. struets. on 8.74 mi. White Settlement Rd., at $60,700; D. H. Purvis, Ft. Worth, Tex., awarded contract for grading 1.76 mi. and constructing draing. structs. on Arlington Grapevine Rd., at $45,984.

Va., Richmond—Atlantic Bitulithic Co. awarded contract for paving at $88,036.

W. Va., Beckley—Sutton Constr. Co., Pikesville, Ky., awarded contr. to grade and drain 4¼ miles Jarrolds Valley-Concord Rd. $100,000 available.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Fullerton—Wm. Ledbetter & Co., Pacific Electric Bldg., Los Angeles, awarded contracts for constructing sludge tank at $16,370 and constructing screening plant at Fullerton Sewer Farm, at $1,004. This contractor also bid $1.85 for 760 ft. 15-in. vitr. pipe, but City decided to put in pipe with its own force.

Cal., Los Angeles—W. A. Frick, 440 S. Daly St., L. A., awarded contr. for constr. of san. sewers on Bway., 6th, Olive and 7th Sts., at $158,776.

Cal., San Leandro—Jas. Tobin, Oakland, awarded contract to constr. storm sewer on Alvarado St.—Saunders St. to San Leandro Crk.—at $16,412; also contr. to construct sewer on Elsie Ave., at $1,096.

Ont., Toronto—R. C. Harris, Works' Commr., awarded contr. for reconst. of sewer on York St., Front to King Sts., at $16,151.

Fla., Bayboro—R. L. West, St. Petersburg Constr. Co., awarded contr. for installing sewage disp. tanks in Bayboro, at $48,000.

Ill., Quincy—Henry Rees & Son awarded contr. for construction of local impvt. known as South End Sewer Dist., at $28,-965; also local impvt. known as N. 12th St. Sewer Dist., at $18,124.

Ind., Indianapolis—Columbia Constr. Co., Indianapolis, awarded contract for impvt. of sewers in and along Buckingham Dr., at $9,500.

Ind., Worthington—D. H. Bond, Vincennes, Ind., award. contr. for san. sewer system, at $109,200.

Ia., Davenport—Independent Constr. Co., 304 Lane Bldg., awarded contr. for sewers in Westholme, 2nd, 3rd, 4th Addns., at $53,-007; A. Kahles, City, award. contr. for constr. of sewer in Elm St., at $1,523.

Ia., Sioux City—J. F. Devlin, local, awarded contract for san. sewers, Lovell and Pavania St; 2,330 lin. ft. 8-in. vitr. clay pipe, $2.38 per ft.; 8 stand. brk. m.h., $114 each; 48 ft. c.i. pipe, $8; J. M. Lewis, 625 5th St., awarded contr. for storm water sewers, 3rd St., Virginia to Court Sts.; 396 ft. 24-in. vitr. clay or conc. pipe; $7.65 ft.; 1,200 ft. 12-in. clay or conc. pipe, $3.32 per line. ft.; Todd Plmg Co., 20 W. 3rd St., awarded contr. for sewer and water connects. in Jones St.—21st to 28th Sts.; 39 sewer connects., $2.90 per lin. ft.; 21 water connects., $85 each complete; 40% bond req.; also contr. for sewer and water connects. in 17th—Court to Cliff Sts., Chase, Taylor and Easleys Addns.; 15 sewer connects., $2.85 per lin. ft.; 6 water connects., $85 each complete; also contr. for sewer and water connects. from 32nd to 36th, Pierce's Addn.; 11 sewer connects., $2.95 per lin. ft.; 16 water connects. $85 each complete.

Mass., Boston—A. Barruffaldi awarded contr. for bldg. sewerage works in Farragut Rd. extension, S. Boston, at $37,397; Jos. Todesca, contract for sewerage works in Cambridge St., betw. Hano and Wilton Sts., Brighton, at $3,126; Timothy Coughlin awarded contract for sewerage works in Amory Ave., Roxbury, at $5,760.

Mass., Boston—Andrews Constr. Co. awarded contract for cleaning pipe and brk. sewers in Cambridge St., under Bost. & Mo. R. R. trks., at E. Somerville Sta., etc.; Samuel J. Tomasello awarded contr. for bldg. sewerage works in Alger St., Dorchester Ave., abt. 540 ft. westerly, So. Boston, at $13,125; Geo. J. Regan awarded contr. for sewerage works in Roanoke Rd., Hyde Park, at $1,158; J. Guarino & Co. awarded contr. for sewerage works in Itasca St., Dorchester, at $10,103.

Mass., Boston—Wm. Barrett & Co. awarded contr. for bldg. catch basins and minor drains, at $13,364.

Mich., Pontiac—Misak Kevorkian awarded contract for surf. drain in Perkins St., Whittemore to Cottage, and in Cottage and Willard west from Perkins St., at $4,872.

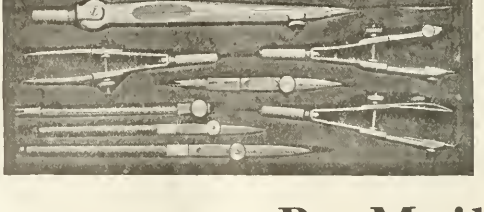
Minn., Cloquet—Pastoret Constr. Co., 510 Lyceum Bldg., Duluth, awarded contract for sewer and water extensions in H Ave., Walnut St. to Laurel St., So. to Carlton Ave. West, at $18,544.

Mo., Joplin—Jno. L. Zeidler, St. Joseph, Mo., awarded contract for sewer system, at $64,650.

Mo., St. Joseph—Thomas & Howard awarded contract for constr. of main sewer in Arthur's branch, at $8,549.

N. J., Paterson—Toriello & Sansome, Hackensack, awarded contr. for bldg. branch intercepting sewer at Lowe Street, Paterson, at $20,000.

N. Y., Brooklyn—Tomasetti Co. awarded contract for bldg. sewer in New Utrecht Ave. at .9598% of engineer's estimate of $26,433; E. 24th St.; from Ave. N to Ave. O and from Ave. L to Ave. M; also in 82nd St., to A. Ferris, 94% of engineer's ests. of $4,425, $5,400 and $5,217, respectively; Warehouse Ave., to Murphy Bros., 122.8% of est. of $8,360.



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EDITORIALS

PROGRESS IN SOLVING THE SUB-GRADE PROBLEM

Recently it was our privilege to listen to such a concise statement of the sub-grade question that we were tempted to conclude that the solution of this vexatious problem will soon be realized, for it has been our observation that once a problem can be stated in brief but detailed terms the engineer is not long in solving it. But, on second thought, one must recognize this problem as one involving many variables and very few known quantities. Much dependence must be placed on empiricism as well as on analysis of local physical conditions. In other words, the solution must be reached through the process of trial and error so familiar to engineers. While great progress is being made, indeed wonderfully gratifying progress, it is only reasonable and fair to conclude that a considerable period of time must pass before the engineer will be justified in feeling that he has solved the greatest of all highway engineering problems, namely, that pertaining to the sub-grade.

We are calling attention to the inevitable delay in reaching the final solution of this problem for the reason that suggestions are occasionally made that the highway construction program be suspended awaiting that event. It would be distinctly unfortunate to adopt such a suggestion for there are many other unsolved highway problems having to do with such considerations as the method of financing construction and maintenance, the regulation of the speed and weight of vehicles, the design of motor trucks with special reference to impact on the highway, and even the innocent appearing question of the width of the paved roadway.

We do not wish to minimize the importance of the sub-grade problem; that is farthest from our intent. But let us not overemphasize its importance for there are other, and will continue to be other, problems for the highway engineer to solve. These problems will all be solved in time, no doubt, and then new difficulties will present themselves in highway work, just as in every other class of work.

The sub-grade problem cannot be worked out entirely on the scratch pad or in the laboratory. Analytical and small scale experimental studies are necessary but not sufficient; they must be supplemented with a great variety of full scale operations in the field. To postpone construction would not aid greatly in solving the problem; it would only postpone the solution and would continue to deprive the public of the use of urgently needed highways. The engineer will gain mastery of the sub-grade only after much study of its many phases and factors. We trust that suggestions of delay in construction will be dropped as ill considered, unwise, and dangerous to the cause of better roads.

TAKING UP THE INDUSTRIAL SLACK

Unemployment grows with the subsidence of the war-time boom in industry. Very frequently one notes news articles to the effect that public officials are being requested to provide work for the unemployed men who are being dropped from industrial payrolls. From a general condition of labor shortage there has been a rapid transition to a state of unemployment which is assuming considerable proportions in those regions where industry has been most affected.

This condition was anticipated by those who have made much study of industrial cycles. Next in order should come a period of great activity in the construction of public works of all sorts. Such projects will provide employment for all labor not needed elsewhere and it is believed that all cities and counties who make any pretense at looking after the welfare of the laboring classes will start construction work as soon as possible so as to provide useful and profitable employment for wage earners.

That there is a tremendous accumulation of public works projects, which have been piling up for several years, everybody knows. If there is a city or county, however, in which improvement projects have been totally neglected, now is the time to get them started. In general, the present winter should be utilized in bringing projects up through the political, legal and financial stages so that, with the return of construction weather, construction may proceed at once without the loss of more time.

We trust that inexperienced public officials, as well as business men seeking opportunities in the construction field, will quickly appreciate that a great construction season impends and that they will plan accordingly. Nothing is to be gained, but much is to be lost, by waiting to see what will happen. Many times in the past construction has been quiet during industrial booms and always with the oncoming of a depression in industry, however slight, there has been a corresponding quickening of all constructional activities. We find no pleasure in calling attention to present industrial conditions and do so only by way of pointing out that the construction man is about to have his inning.

Resurfacing Worn Out Macadam Pavement at Dubuque, Iowa

Using Bituminous Concrete Binder to Shape Up Old Pavements

By Hugh W. Skidmore, of Chicago Paving Laboratory, Consulting and Inspecting Engineer, 160 N. Wells St., Chicago, Ill.

The preservation of existing pavements has always been worthy of serious consideration. Judicious treatment of old pavements resulted in remarkable savings even in the days of low prices; hence, with the advent of present day construction costs, the value of the assets existing in old pavements, has increased to such an extent as to attract the attention of engineers and public officials generally. Many have been surprised at the results obtained and the number of converts to the saving of old pavements has steadily increased.

Reclaiming Grand View Ave., Dubuque

The redemption of a worn out macadam pavement, which during a short life had given most unsatisfactory service, has recently been accomplished at Dubuque in the case of Grand View Ave. The condition of this pavement prior to resurfacing was such that more or less skepticism as to its value as a foundation was to be expected. While the opinion of interested property owners may be, and very often is adverse to a proposed improvement, such objections are usually the result of an erroneous premise, and should not receive too serious consideration from the engineer; nevertheless, confidence in the engineer's judgment, on the part of the taxpayers he serves, is gratifying. It was pleasing to note the increasing satisfaction among the residents along the street as the work progressed.

The Methods Employed

It is thought that the methods employed in resurfacing this pavement are in accord with sound engineering principles and that a number of the conditions encountered are sufficiently common to work of this nature to render an account of some interest. A few months prior to awarding the contract, late in the summer of 1919, a thorough examination of the old pavement was made by the city engineers and the writer. Conditions which were found to exist were such as to make desirable certain changes in the original plan of procedure as adopted by the City Council. The original program, which called for 2¼ ins. of bitulithic wearing surface, made no provision for treatment of recently excavated trenches or poorly drained portions of the subgrade and did not contemplate any means of building up depressions in the old pavement. The contract as finally awarded, however, provided for the use of bituminous concrete binder, coarse mixture, with special treatment of trenches and doubtful portions of the subgrade as directed by the engineer.

Grand View Ave. serves as one of the principal in-and-out thoroughfares of the city, so that given a good pavement surface, it might be expected to attract considerable motor traffic, with pleasure cars predominating. The street was laid out approximately along the top of a ridge with a central parkway and two drives. The topography is such that there is a considerable natural fall longitudinally of the pavement in the direction of the open country. The portion resurfaced is about 1 1/3 miles in length and contains some thirty odd thousand square yards.

Poor Drainage Chief Cause of Former Failures

With the soil conditions which prevail generally throughout the residence portions of the city, good natural drainage might be expected along Grand View Ave., particularly in view of the slope in both directions from the pavement for the greater portion of its length. It was found, however, that probably the chief cause of rapid deterioration of the old macadam was due to lack of adequate drainage. No doubt this defect was largely accountable to the fact that when the pavement was originally laid out, proper advantage was not taken of the natural lay of the land and apparently the question of drainage appeared as an insignificant item to those responsible for the design. Aside from the fact that no storm sewer exists in the street, two primary causes contributed to poor drainage of both surface and sub-surface: first, the impervious clay subsoil; second, extremely flat pavement sections with no provision for frequent diversion of surface water, resulting in the flooding of long stretches.

Owing to the peculiar topography, much of the adjacent property is unsuitable for dwellings, consequently there is considerable distance between cross streets. At the upper end, a Y-shaped intersection is formed by the convergence of two other streets with Grand View Ave., and it so happens that both of these converging streets deliver an enormous volume of storm water into this intersection. It was found that there were no catch basins in this intersection and that the pavement was designed with a "dish" so that all of the water arriving at this point was discharged into Grand View Ave. The natural effect of poor design, therefore, was to maintain a saturated subsoil and macadam structure during a considerable portion of the year.

Trenches Facilitate Examination

An excellent opportunity for examining the subsoil and road metal was provided by the excavation of plumbers' ditches a few months prior to construction. Installation of water and gas services in front of all vacant property, while it provided this opportunity for an examination of soil and structural conditions, at the same time made necessary extra precautions in protecting the trenches

against future settlement. As previously mentioned, the soil was found to be impervious clay. A thorough examination of the macadam structure revealed the fact that the pavement had been originally laid on a Telford base, which had been resurfaced with macadam only a few years prior to this examination, and that as a general rule, the entire central portion of each drive had little, and oftentimes practically no surfacing material left, thus exposing to traffic the Telford foundation. More or less concentrated traffic along the central portion of each drive had resulted in reducing an extremely flat pavement section to a very irregular concave surface. It was at once apparent upon examination that there were many portions of the pavement which would require several inches of new material in order to provide the proper elevation and crown. It was also found that there were a number of sections of the subgrade which were very unstable during wet weather.

Observation following heavy rains revealed mud working up through the base in several places. Inspection of these areas was made with a view to determining whether or not the soggy condition was primarily due to poor under-drainage, and if poor surface drainage was found to be the chief source of the trouble, whether or not it would be safe to assume that this condition would be relieved upon building up the structure to proper grade and contour and providing a water-tight surface. In several instances it was found that excavation of the unstable material was desirable and that under-drainage would be necessary. Examination of the intersections indicated that all of them would have to be reshaped in order to divert storm water from Grand View Ave. instead of carrying it along the pavement as had theretofore been done.

VIEWS SHOWING THE RESURFACING OF AN OLD MACADAM PAVEMENT ON GRAND VIEW AVENUE, DUBUQUE, IOWA. Left: Binder Course Ready for Top. Center: After Resurfacing. Right: A Badly Worn and Almost Impassable Roadway Converted into a Smooth and Serviceable Traffic Floor.

Some New Curbing Necessary

The old stone curb around the central parkway was found to be badly out of line and generally in poor condition; the combined curb and gutter along the outer edges was found to be in fair condition. However, owing to the elevation of the macadam adjoining the gutter, and in view of the proposed general raise in grade of the pavement, it would be necessary either to reconstruct the gutters or carry the wearing surface over their tops to the face of the curb. (The latter was recommended and the former was adopted by the Council.) As is often the case in resurfacing old pavements, it was thought that some alteration of the curb and gutter grades would improve the general drainage ability of the pavement. However, as is likewise usually the case, radical changes of this nature were to be avoided as far as possible in order to preserve existing improvements, such as sidewalks, carriage walks, intersecting curbs, parkways, etc.

Conclusions and Recommendations Following Examination of Old Pavement

In summing up the evidence brought out by careful examination of the old pavement, with respect to such local conditions as had contributed to failure in the past and were likely to have a similar effect in the failure, it was readily seen that a well defined and carefully executed construction program was imperative; one which would include such essential items as (1) excavating and refilling, with stone or gravel, such portions of the subgrade as were found to be unstable, and the use of tile drains where necessary; (2) a general raising of the entire pavement surface to provide sufficient longitudinal and cross fall to prevent any possible detention of surface water, this to be effected by the employment of bituminous concrete binder over practically the entire surface of the old road-bed, with the additional use of broken stone, thoroughly tamped and rolled, in some of the more extensive areas which were found to be several inches below the desired grade; (3) the employment of extra precautions in backfilling trenches so as to provide a uniformly unyielding subgrade, the accomplishment of which would require filling with stone or gravel in layers not to exceed 1 ft. in depth, with thorough tamping and puddling and, finally, if any trenches revealed signs of weakness under the final rolling of the subgrade, they should be reinforced with concrete flat arches having a bearing on solid earth entirely around the opening; (4) scarifying or cutting into the old metal was not to be permitted under any circumstances, it being deemed imperative to preserve in a compact condition the original pavement, and if necessary, to accomplish this the grade in general would be raised sufficiently to avoid the necessity of cutting down even small areas; (5) raising the gutter grade over the entire job in order to provide for thickness of the wearing surface; (6) building a concrete curb around the central parkway; (7) providing transverse fall of not less than 1/3 in. to the foot and raising intersections in order to turn surface water into cross streets; (8) thoroughly cleaning the surface of the old pavement by means of a rotary street broom prior to the application of binder or crushed stone; and last, but not least, (9) the employment of rigid inspection by experienced men.

Construction Progress Delayed by Wet Weather

The work was done in accordance with the recommendations with the one exception mentioned above;

that is, new concrete gutters were laid instead of carrying the asphaltic concrete top over the old gutters. Some of the new gutter was broken down by traffic and contractor's rollers prior to laying the wearing surace. Final examination of the work indicated that forming gutters with the asphalt mixture would have been more satisfactory.

Owing to the condition of the old pavement, it was highly desirable to carry on the work during dry weather insofar as possible. Unfortunately the contract was not let until late in the season, and construction of the pavement was delayed until late October, 1919. During the late summer there had been considerable rainfall, so with construction starting as late as it did, it was anticipated that a more or less saturated subgrade would be encountered. For this reason, the city officials were warned against the dangers attending work of this nature during a period when the subgrade would have no opportunity to dry out between rains.

However, the contractor was anxious to complete the first section of the contract (about 10,000 sq. yds.) before cold weather, so the work went forward, about 5,000 sq. yds. being laid before it became necessary to order the work stopped on account of wet subgrade, following several days of bad weather. The work which was laid in 1919 was rather irregular as to surface and in this fell short of expectation. Upon examination in the early spring, there were no signs of subsidence, so it was thought that the appearance of the pavement would

RESURFACING WORN OUT MACADAM ON GRAND VIEW AVE., DUBUQUE, IOWA.

To Avoid Interrupting Traffic one Driveway was Laid Complete Before Commencing Work on the Other Drive. Workmen are Spreading Seal Coat Over Bitulithic Wearing Surface. Uncovered Binder and Prepared Subgrade Shown in Foreground.

improve under warm weather traffic. Later investigation proved this assumption to be correct, although at the time of final inspection there was a marked difference between the 1919 and 1920 work so far as surface was concerned.

Work was resumed the following spring as soon as weather conditions would permit. The effect of dry weather was very apparent in the finished work; all of the pavement laid in 1920 presented an unusually smooth and regular surface, and the quality was excellent in all stages of construction. None of the backfilled trenches or refilled subgrade areas evidenced the least signs of subsidence under a 15-ton, 3-wheeled roller.

The binder average 1½ ins. in depth for the entire job and 1.8 ins. for 19,000 sq. yds. Actually it was as much as 3 ins. thick in places, while in a few small areas it was not necessary to lay any binder at all. The total thickness of bituminous material was 3¾ ins. on the average over the whole job, with an average thickness of 4.05 ins. over approximately two-thirds of the total yardage. Inasmuch as the old pavement was generally in such poor condition, it possessed only limited value as a

VIEW OF GRAND AVE., DUBUQUE, AT A POINT ON TOP OF A RIDGE.

View Shows Loose Stone in Depressions of an Intersection Prior to Rolling and Indicates that Pavement has been Raised Several Inches to Provide Proper Fall.

foundation, but might well be considered in the light of an artificial subgrade possessing more desirable qualities than the average natural subgrade, inasmuch as it was thoroughly compacted and thereby was given increased structural strength and greater shock absorbing ability than would ordinarily be the case with an earth subgrade. In addition to these virtues, the presence of the macadam immediately beneath the bituminous structure would also have a tendency to facilitate drainage. Therefore, although the total thickness of pavement is less than would be designed for bituminous base construction to meet the traffic and soil conditions which prevail in this instance; nevertheless, it seems only logical to classify this resurfacing work under the head of asphaltic concrete base laid upon a somewhat superior artificial subgrade.

For shaping up an old pavement, whether brick, block, macadam or gravel, there is no material which lends itself so readily to the purpose as does bituminous concrete binder.

Resurfacing a Good Investment

It is thought that this and other similar work in Dubuque during the past two years has not only been the means of converting old, worn out and almost useless roadways into substantial pavements of pleasing appearance, excellent riding qualities and with potential lives of long and useful service at a minimum maintenance expense, but also represents a very handsome saving to the taxpayers in the way of initial cost.

THE COMBINED-TYPE SEWAGE SETTLING TANK

To the Editor:—Referring to Mr. W. G. Kirchoffer's article in Municipal and County Engineering for

March, 1920, entitled "Operating Experiences with Imhoff Sewage Tanks," the design there described resolves itself into an upward-flow tank followed by an Imhoff unit to redeposit any matters unloaded by the primary unit. No advantage is to be gained by constructing the characteristic Imhoff sloped walls for flowing-through chambers over the Dortmund portion; in fact, the increased velocity of flow at the slots would tend to detract from the efficiency of the primary unit.

Reduced to its lowest terms, this in an upward-flow tank followed by an Imhoff trap tank. It is obvious that a horizontal-flow, single-story tank, may be used for the primary unit in place of the Dortmund feature, though not, in the experience of the writer, with equally good results. An important feature of such combinations is this: The primary unit, whether in the form of a horizontal-flow, single-story, or of a Dortmund unit, will unload solids through gas disturbances. These solids, being largely gas-lifted sludge, will not redeposit in the Imhoff unit unless the entrained gases are first liberated. For this purpose I have used a splash board at the entrance to the Imhoff unit, with a drop of 8 ins. or so, which provides a vigorous agitation, sufficient to release the entrained gases and permit solids unloaded by the primary unit to settle in the secondary.

The foregoing combination was suggested by the writer in an article in the Engineering Record in 1916 or 1917, with an illustrative cut. Following experiments at a test plant at the factory of the Agasote Millboard Co., in Trenton, N. J., in 1917, I installed an institutional plant at the Valeria Home, Croton-on-Hudson, N. Y., in 1919, which contained these features. The plant is most successful.

It will be apparent to the reader that a large municipal plant could be constructed in the form of a number of primary units, the combined effluents of which would be passed through a single short period Imhoff unit, with provision for gas liberation at its inlet.

To secure the best results in the primary unit, the influent should be introduced in such a manner that it will pass continuously upward through the sludge accumulations. In this manner a "colloidor" is secured, wherein the sewage is brought into prolonged and intimate contact with the multitudinous surfaces of the sludge particles, which act as colloidor surfaces. In this way a high degree of clarification is secured. Contrary to expectation, the writer has not found this to materially increase the amount of matter in solution.

When using this design in my practice, I have referred to it as a combined-type tank.

Very truly yours,

WALDO S. COULTER,
Consulting Engineer,
114 Liberty St., New York, N. Y.

Sept. 24, 1920

(The foregoing letter was brought to the attention of Mr. Kirchoffer and he has, on our invitation, submitted the following comments on the points brought out by Mr. Coulter. This is an important and timely topic for consideration and we shall be pleased to extend the discussion at our readers' pleasure.—Editor).

To the Editor:—I have read Mr. Coulter's discussion of his "Combined Type Tank" with much interest. The fact that he, as well as many others, have found it advisable to modify the Imhoff tank, more thoroughly convinces me that my own designs are an advancement in the art of sewage disposal. It could hardly be expected that when thousands of engineers, chemists, bacteriologists and others of scientific training are working on the art of sewage disposal that two or more should not be thinking and working along similar lines, in fact, some may have exactly duplicated the work of others.

It is not at all surprising that out of some dozen or more prominent engineers, editors and heads of health departments, that have expressed their views on my new form of tank, that there should not be at least one, such as Mr. Coulter, whose views might differ from mine or who might claim to have been the real originator of the new type of sewage tank. It is the same old story of "I told you so." Many persons have bright new ideas, some good, some bad, who never have the nerve or fortitude to put them before the public for discussion or use.

I recall that some nineteen years ago I conceived the idea of making a profile of a road mechanically by attaching a mechanism to a wheel revolving along the surface of the road. I never made use of it, but I have since learned that such an instrument is being manufactured in Detroit, Mich. Should I now claim to be the inventor of the mechanical profiler?

A friend of mine recently wrote me that soon after he was out of school, about 20 years ago, he conceived an idea for the purification of sewage by the use of compressed air, but he did not put it into practice. Therefore, is he the inventor or discoverer of activated sludge? (He laughs at the suggestion.) I recall very well seeing the illustration of the tank to which Mr. Coulter refers. I claim that my new tank which I have named "Kirdorthoff" is in no sense a duplicate or copy of Mr. Coulter's tank. I claim that the very feature which he so emphatically denounces in the first paragraph of his discussion is the leading feature which makes this new tank an advantage, in certain cases, over older types of tanks. I do not claim that this feature is essential in all cases. A sewage which is old on arrival at the disposal works, and especially one that has been more or less digested by pumping or other violent agitation, would no doubt be treated equally well by separate sludge digestion tanks or possibly by a plain Imhoff tank. The Kirdorthoff tank is particularly adapted to fresh sewages containing greasy matters such as will be found in thousands of our small cities and villages. The very slot which Mr. Coulter condemns really acts to prevent the gas lifted sludge and greasy matters from entering the upper chamber and flowing away with the effluent, which is a common fault with every type of tank of which I am familiar. I claim that a tank not so trapped with hoppers and slots in the primary chamber, and my experience bears me out in this, will in time discharge gas lifted and greasy sludge to the secondary chamber.

In fact I consider the primary chamber with its slot and upward flow more essential to the proper treatment of the sewage than is the second chamber which Mr. Coulter says is no more than a plain Imhoff tank.

I cannot agree with Mr. Coulter that plain septic tanks or possibly some other type giving similar results will be beneficial or advisable to use for preliminary treatment ahead of an Imhoff Tank. I have experimented with large sized separate sludge digestion tanks and plain sedimentation tanks for months at a time. All of these give good results for a period of 6 to 8 weeks, but after a septic condition becomes general throughout the mass of

retained sludge, the effluent is no longer clear or free from gas lifted sludge particles. What I have had to say, in answer to Mr. Coulter's discussion of the "Combined Type" tank, is based not upon a theory or a "hunch" that I have received or devised, but upon actual experience covering a period of several years.

I also might add, for the benefit of those who wish to make use of my contribution to the art, that this type of tank is not as completely automatic as the inventor of the septic tank unfortunately led us to believe his tank to be. If the sludge is not removed from the sludge digestion chamber at intervals, if the surface is not freed of any scum and the slopes of the hoppers cleaned occasionally, difficulties will arise sooner or later with this as with all other types of tanks, but under proper care and applied to the right sewage in a proper design, I claim that it is the best solution for tank treatment that I have found.

What we wish to do is to place the solids in the bottom of a tank where they can be digested; why wait for gravity to draw them down? It seems to me that the logical thing to do is to place them there at once by having the inlet at the bottom rather than at the top of the tank. We wish to keep gas lifted and similar sludge and scum from flowing out with effluent. Therefore the logical thing to do is to provide means in the tank so that these particles can rise to the surface of the liquid where they can free themselves from gas and at the same time be drawn into the current of the effluent to a minimum degree.

Mr. Coulter would liberate the gas by means of a water fall at junction of tanks. This may aid in the liberation of gas but my experience would point to the conclusion that it would also tend to divide the particles of sludge into smaler units and possibly beat some of them into a colloidal state, which would be difficult to break up in the short period allotted to tank treatment.

In conclusion I wish to express the opinion that we have only "scratched the surface" of the art of sewage treatment; there is a vast amount of work to be done yet before the last word can be said on the subject. It is easy to lead a horse to water, but few there are that can make him drink. It is easy for the inexperienced to design disposal tanks, but it generally takes an experienced operator to make them work.

Very truly yours,

W. G. KIRCHOFFER,
Consulting Engineer,
22 N. Carroll St., Madison, Wis.

Nov. 8, 1920.

LEGISLATION AFFECTING MUNICIPAL ENGINEERING

By A. W. Consoer, Manager, Consoer Engineering Co., 1654 Monadnock Block, Chicago, Ill.

Municipal improvements have always afforded a large field of work to engineers in private practice and to engineers in the public service. Yet it is surprising to note to what a slight extent the interests of the public, and of engineers engaged in municipal work, are protected by legislation which will prevent the construction of public works unless the proposed improvements have been designed by competent engineers and are constructed under able engineering supervision. Some progress in correcting this condition has been made in certain states, but engineers as a class have ever been reluctant to engage in lobbying or to use other methods for securing the enactment of remedial legislation. Because of the failure of engineers as a class to secure the requisite protective legislation instances of mal-practice in municipal engineering are found in many cities and villages.

State Regulation is Efficacious

While the administration of the Department of Public Works in many cities leaves much to be desired, the situation is particularly deplorable in some of the smaller municipalities. In some states the statutes require that plans for the installation of municipal water supplies, sewer systems, water purification and sewage disposal plants must be submitted for approval to some State Department, usually the State Board of Health, before such works can be installed. In many states no such requirement is made; in some the matter of securing such approval is optional, and in almost all states extensions and changes in existing municipal improvements are attempted without state supervision. Not all municipal engineers will agree that state regulation of municipal engineering is desirable, but that it is efficacious in many cases cannot be denied.

Fortunately the laws for the licensing of engineers, which have been passed in several states and are being proposed in others, will help to improve conditions in the field of municipal improvements. To be most effective in correcting abuses in public work, a license law should provide that no municipality can undertake the construction of any improvement of appreciable size except under the supervision of a licensed engineer.

Engineering Council's Model Law

Engineering Council's recommended model law for the registration of professional engineers, architects and land surveyors provides that one year after the act goes into effect neither the state nor any political subdivision shall engage in public work involving professional engineering or architecture for which the plans, specifications and estimates have not been made by, and the construction and maintenance supervised by, a registered professional engineer or a registered architect; provided the contemplated expenditure for the completed project exceeds $2,000. When a law similar to this is on the statute books of every state many of the disheartening features of municipal practice will be eliminated.

The license laws of Florida, Michigan, New York and Wyoming have specific clauses similar to the one recommended for public work by Engineering Council. The Idaho law has a clause concerning the filing of plans by municipal authorities which is intended to accomplish the same results as the clause quoted from the model law. In one state which has a license law that contains no clause referring specifically to public work the Attorney-General has ruled that no political subdivision of the state can legally employ any engineer and surveyor who is not licensed. The practice of municipal engineering will be bettered by the adoption of a uniform law in all states with a clause referring specifically to public work.

In many municipalities improvements of considerable importance are often carried out without engineering advice, and sometimes the class of work produced by the city engineer furnishes a powerful appeal for some kind of state supervision. That this exercise of "home rule" in engineering matters leads to some ill-considered under-

takings on the part of some municipal officials is a fact that is well known to every engineer.

Some Examples of Bad Municipal Engineering

Instances of "rule of thumb" municipal engineering and bad practice have come to the writer's attention recently which illustrate the evils of the administration of public improvements as it exists in many cities and villages.

A certain village wished to pave a system of streets, and the Village Board assured the engineer that their sewer system was "all in." Upon investigation it was found that a sewer system had been built piece-meal. Some of the pipe was standard vitrified pipe and some was drain tile. The system, comprising about three miles of sewers, included only four manholes. No records of the locations, sizes and grades of the various sewers had been kept. Much of the work had been done without having any grades set, and none of the work had been inspected during construction.

In another city the writer witnessed recently the construction of a comprehensive system of paving where the storm water inlets are all being connected to an existing system of tile drains, the largest of which is reported to be 8-in. in diameter, and all of which is on rather flat grades. In this same city concrete for the paving was being mixed from 10 to 20 seconds on the day of the writer's visit, and the inspector was exultant about the yardage the contractor was laying each day.

In a city which has a population of 8,000, has many industries, and has considerable motor truck traffic, the standard type of pavement has been and still is vitrified brick on a cinder foundation. An argument in favor of this type of construction was advanced by the mayor. He stated that because the sewer and water systems were in bad condition it was often necessary to dig up the pipes, and so they had to use a pavement which could be taken up with little expense whenever necessary.

Another instance that will bring a smile to the lips of many hydraulic engineers concerns a village which went ahead with the development of a deep well water supply after refusing to engage a consulting engineer to direct the work. The board members could not understand why the new well had failed to show a trace of water down to 500 ft., while the old well which was nearby was only 400 ft. deep and was yielding 150 gal. per minute. They were told that possibly the supply of water had been cased off by the well-driller. They were then ready enough to avail themselves of the services of a consulting engineer.

The writer knows of several recent instances where paving systems were constructed without first installing all sewer and water connections into vacant property. In many small municipalities it is not at all uncommon to find a system of sanitary sewers being used to carry storm water as well. Municipalities often purchase pumping equipment solely upon the representations of machinery salesmen. Many cities and villages are so partial to the use of 4-in. pipes in their water distribution systems that, as a result, provision for adequate fire streams is not made. It is usually found in the smaller towns that complete records of the underground work as actually installed are not available.

A city of 60,000 inhabitants recently constructed a large reinforced concrete bridge. The city did not retain a bridge engineer to prepare plans and specifications, but invited contractors to make proposals based on designs to be furnished by themselves. No compensation was given unsuccessful bidders for the cost of preparing designs, and the plans of the successful bidder were not checked by a competent engineer.

These examples of public works constructed without proper engineering supervision are so numerous that they should make a strong appeal to the various sectional and local engineering societies, and to engineers individually, to promote the passage of helpful state legislation which will correct the abuses inherent in municipal affairs in many places under existing statutes.

Recommendations on Legislation

License laws for engineers to be introduced at the coming sessions of the various legislatures can include provisions making it illegal to expend funds for municipal or county improvements which are not designed and built under the supervision of licensed engineers. License laws already passed can be amended to include these same provisions if they are not now included in the law.

Supervisory powers of State Boards of Health or other State Bureaus over the construction of water supply and sewerage works can be established or strengthened. It must be recognized that any new engineer's license law will admit to private practice or municipal service many men who are not fully competent to design and supervise the construction of municipal improvements; and to direct the activities of this class, state supervision is desirable, in the writer's opinion, for the present at least.

In many states the laws applicable to the construction of public improvements by special assessment can be much improved; and engineers engaged in municipal work can interest themselves actively in securing the enactment of new Local Improvement Acts. Features in the existing laws which cause considerable delay and uncertainty in the construction of local improvements by special assessment should be eliminated. In many states the Local Improvement Acts foster the evils of the contingent fee, which has always been the cause of much inferior work in municipal engineering.

What is true of present legislation for constructing municipal improvements is also true in many cases of the laws applicable to the organization of drainage and levee districts. Engineers engaged in drainage work and those doing municipal work can co-operate in efforts to amend or change the laws governing their respective activities. To do so will encourage work of this kind and will protect the interests of the public and of the engineers engaged in these classes of work.

The activities of municipal engineers have been seriously curtailed in recent years by a serious lack of revenue in many municipalities. Frequently funds have not been available to engage engineers to undertake investigations of much needed improvements. In many places the limit for bonded indebtedness fixed by statute is so low as to hinder or block the proper development of a city plan. While the railroads, industrial plants and labor have been able to secure increased revenue, cities and villages are often struggling along today with a pre-war income. The result is that public works which are urgently needed and earnestly desired by urban populations cannot be started until legislation is passed

which will grant to the municipalities revenue sufficient for their needs.

There is, then, a field of work for engineers in securing remedial legislation which will be of vital importance at the coming sessions of the state legislatures. It is work that should make a special appeal to local and sectional engineering societies. The national engineering societies have already commenced their campaigns for the uniform license law in all states, and will surely cooperate in securing other legislation which will increase the prestige of municipal engineers. The municipal engineer can by his individual efforts assist very materially in placing his branch of the profession on a cleaner and saner basis.

SPECIFICATIONS FOR ASPHALT PAVING

The Asphalt Association, 25 West 43rd Street, New York, has ready for circulation in printed form the following typical specifications prepared by its Technical Committee which is composed of highway engineers and specialists. In the preparation of these specifications special attention has been paid to form and arrangement with the idea of making them definite, concise and free from ambiguities. The printed specifications are on single fold sheets of the size adopted by the U. S. Bureau of Public Roads, most of the State Highway Commissions, and many municipalities.

Printed Specifications

A-1 Asphalt Macadam Surface Course.
A-2 Asphaltic Concrete Surface Course. (Coarse Graded Aggregate Type).
A-3 Asphaltic Concrete Surface Course. (Fine Graded Aggregate Type).
A-4 Sheet Asphalt Binder and Surface Courses.
B-7 Asphaltic Base (Asphalt Macadam Type).

Mimeographed Specifications

A limited number of the following specifications in mimeographed form may also be obtained upon request:

A-5 Asphaltic Concrete Binder and Surface Courses.
B-1 Gravel Base.
8-2 Macadam Base.
B-3 Reconstruction of Old Macadam to Serve as Base Course.
B-4 Telford Base.
B-5 Portland Cement Concrete Base.
B-6 Truing Up Old Pavements to Serve as Base Course.
C-1 Preparation of Subgrade.
C-2 Sub-Base.
C-3 Shoulders, Headers, Curbs and Gutters.

Specifications for Asphaltic Base (Asphaltic Concrete Type) will be available for distribution in the near future.

How Specifications Were Prepared

During the preparation of these specifications the committee had before it the specifications of every State Highway Department in the United States, as well as those of a large number of the principal counties and cities of the U. S. Bureau of Public Roads. The opinions of many prominent highway engineers were obtained and digested. The committee, with Mr. Prevost Hubbard, formerly Chief of the Division of Tests and Research of the U. S. Bureau of Public Roads as chairman, was composed of engineers having long practical experience upon highway and pavement construction and design. In order to make them applicable to varying conditions throughout the United States, each printed specification is accompanied by a notice to engineers which will assist the engineer in modifying it if necessary to meet his particular requirements.

Some Fundamental Features

A few of the fundamental features of the specifications are as follows:

A-1 Asphalt Macadam Surface Course.

A minimum thickness of 2½ ins. utilizing a coarse aggregate of 1½ to 2½ ins. crushed stone and asphalt cement of from 80 to 150 penetration are recommended. The limits of penetration of the asphalt cement are to be specified by the engineer within a ten point range if below 90 and within a 30 point range if over 90 penetration.

A-2 Asphaltic Concrete Surface Course. (Coarse Graded Aggregate Type).

A finished thickness of 2 ins. of asphaltic concrete composed of coarse aggregate 95 per cent. of which will pass a 1¼-in. screen, fine aggregate, 4 to 6 per cent. of filler, and 5 to 8 per cent. of asphalt of from 50 to 70 penetration (10 point range fixed by engineer) are the outstanding features.

A-3 Asphaltic Concrete Surface Course. (Fine Graded Aggregate).

A finished thickness of 2 ins, with coarse aggregate 95 per cent. of which passed a ½-in. screen, sand, 7 to 11 per cent. of filler, and 7.5 to 9.5 per cent. of asphalt with a penetration of 50 to 70 (10 point range fixed by engineer) are recommended.

A-4 Sheet Asphalt Binder and Surface Course.

Binder and surface courses each having a thickness of 1½ ins., binder course to have 60 to 80 per cent. coarse aggregate, sand, and 4 to 6 per cent. of bitumen, the asphalt cement for both courses to have a penetration of from 30 to 6 with a ten point range fixed by engineer. The surface course mixture is as follows:

Passing 10 mesh, retained on 40 mesh..... 10 to 40%
Passing 40 mesh, retained on 80 mesh..... 22 to 45%
Passing 80 mesh, retained on 200 mesh..... 12 to 30%
Passing 200 mesh ..... 10 to 20%
Bitumen .....9.5 to 12%

B-7 Asphalt Base (Asphalt Macadam Type).

To consist of two courses—the first to have a thickness of 3½ ins. and the second 2½ ins., coarse aggregate for the first course to consist of 2½ to 3½-in. stone and for the second course 1¼ to 2½-in. stone, asphalt cement to have penetration of from 80 to 150 (fixed within a 10 point range if less than 90 and a 30 point range if over 90, by engineer), one application of asphalt at the rate of 1.25 to 1.5 gals. per sq. yd. to be made upon each course, and the second course covered with a thin layer of ¾ to 1¼-in. stone.

A-5 Asphaltic Concrete Binder and Surface Courses.

This specification provides for a 1½-in. course of fine graded aggregate asphaltic concrete wearing course as specified under A-3 laid over a 1½-in. binder course as specified under A-4.

B-1 Gravel Base.

To consist of two courses each not less than 4 ins. in thickness after compaction, 95 per cent. of the gravel to

pass 3½-in. screen and 50 to 75 per cent. to be retained upon a ¼-in. screen.

B-2 Macadam Base.

To consist of two filled courses each not less than 3 ins. in thickness, 95 to 100 per cent. of the crushed stone to pass a 3½-in. and 0 to 15 per cent. a 2½-in. screen, 95 to 100 per cent. of the screenings to pass a ¾ or ½-in. screen and 40 to 80 per cent. a ¼-in. screen.

B-3 Reconstruction of Old Macadam to Serve as Base Course.

Provides for reconstruction of old macadam in order to secure a minimum thickness of 6 ins. after compaction.

B-4 Telford Base.

Provides for hard laid 8-in. Telford Base.

B-5 Portland Cement Concrete Base.

A mixture in the proportions of 1:3:6 with a thickness of 6 ins. is specified.

B-6 Truing Up Old Pavements to Serve as Base Course.

Provides for truing up old pavements by the use of an asphaltic concrete mixture in preparation for the application of an asphaltic wearing course.

C-1 Preparation of Sub-Grade.

(No explanation required).

C-2 Sub-Base.

Provides for a sub-base of field stone filled with smaller fragments and compacted.

C-3 Shoulders, Headers, Curbs and Gutters.

Provides for gravel, water-bound and asphalt macadam shoulders, and portland cement concrete headers, curbs, and gutters.

MAKING NEW GRANITE PAVEMENT FROM OLD BLOCKS FOR NEW ORLEANS CAR TRACKS AT SAVING OF 50 PERCENT

By John C. Bartley, 712 Hennen Bldg., New Orleans, La.

Memories of the fairy tale of childhood about the peddler who wandered through the streets of the Arabian city offering to exchange "new lamps for old" are revived in a piece of paving work recently completed by the New Orleans Railway and Light Co., under the direction of their chief engineer, Mr. M. V. Houlard.

In the days when this city went from cobble stone paved streets to the more enduring large square block granite roadways there was a section of the town which was adorned with blocks from the granite hills of Maine. That this granite served its purpose well and faithfully was never questioned, though it failed to come up to the present-day requirements, and with the drainage of the city and the substitution of deep, open gutters, with terra cotta pipe, there was then no need of these highly crowned roadways, so necessary in the early days of street construction, some 50 or 60 years ago. It was destined therefore to go into the discard in the march of progress, and residents along this thoroughfare, formerly the eastern boundary of the city, were not surprised to learn one day that the city fathers had decided to remove the granite and to replace it with a more expensive and modern pavement, in conformity with an elaborate program of street improvement.

When the old large blocks were removed they were split into quarter sections, approaching in size the standard 5-in. granite block, and the New Orleans Railway and Light Co. acquired these blocks, purposing to lay them in their car tracks.

The first opportunity that the company has had to use this material in rail construction recently presented itself, when the blocks were laid between the tracks along a section of Camp street up from Canal street, the city's main promenade boulevard. The result was highly satisfactory. That part of the paved roadway lying between the tracks is as pleasing to the eye as the outlying sections, from the car tracks to the sidewalks, laid with asphalt, and presents a smooth, firm surface. It is more enduring than the high priced pavement that replaced the old square granite block on the street from which

VIEWS OF OLD AND NEW GRANITE PAVEMENTS IN NEW ORLEANS USING SAME BLOCKS.

Top: Old Square Granite Block Street-Center: Ordinary Construction Between Rails with Re-cut Granite Blocks Laid at Same Time Blocks with Mastic Filler were Laid. Botton: Re-cut Blocks Laid with Asphaltic Cement and Hot Sand Filler After One Year in Service.

these blocks were removed, recalling the story of Aladdin and His Wonderful Lamp.

The old track foundation was not disturbed, except where new rails were placed, some ballasting was done and the blocks were laid in a cement sand cushion. The mastic filler was used—equal parts of hot asphaltic cement and hot sand. The asphaltic cement was heated on the job to a temperature of 360 degrees Fahrenheit, but no facilities were available for heating the sand, and it had to be heated at the local asphalt plant, at about 400 degrees Fahrenheit, before being hauled to the works. The temperature in the sand was maintained undiminished, the sand being about the same temperature when mixed with the asphaltic cement. The mixing was done in iron barrows with hoes, the mixture being sufficiently agitated to produce a uniform mix. It was then poured into the joints and a very thin coat squeegeed over the blocks—just sufficient to be sure the joints held.

There was no interruption to the running of the street cars, and but slight delay to vehicular traffic. Only one side of the street was treated at a time; as soon as the stretch was finished and sanded it was thrown open to traffic.

While the work was under way skeptics among the onlookers expressed the opinion that it would not hold, alleging that the summer heat would so soften the filler that the joints would break and the blocks would rock loose. No sign of weakness has evidenced itself in any part of the construction, despite the intense heat of the past summer.

Fig. 1 is a typical New Orleans old square granite pavement, now fast disappearing, and being replaced by modern construction and with other types of surfacing. Fig. 2 shows these old square granite blocks split up into blocks of smaller size and laid between the street car rails. Fig. 3 shows similar blocks recut from the old square granite blocks and laid on a portion of Camp street with hot asphalt and hot sand filler.

The conservation of old granite blocks by recutting them into smaller size and employing proper methods of construction has not only saved the railway company fully 50 per cent. in cost of new material, but has provided a sanitary, noiseless and smooth riding surface for automobiles and an enduring pavement for the heaviest kind of traffic.

SOME FEATURES OF HIGHWAY MAINTENANCE WORK IN PENNSYLVANIA

By George H. Biles, Assistant Commissioner, State Highway Department, State House, Harrisburg, Pa.

To maintain means to hold or keep in a particular state or condition, and this is a big problem today with our highways, due to the rapid evolution of traffic in recent years. We emerged almost over night from the era of horse-drawn traffic to the motor and, subsequently, to the heavy trucks. Idealists tell us that roads should be constructed to accommodate all forms of vehicular traffic. While we cannot help but feel there is some measure of truth in such a theory, we know that from the practical standpoint there is not enough money or resources in the country to carry out such ideals in the way that can bring relief to the situation for many years to come.

In the interim we have on our hands a vast mileage of the so-called obsolete types which must be kept up and to which must be applied the best principles of modern maintenance. At the same time, deference must be given these highways by our Legislators in fixing by statute the loads to be carried.

For example, the great State of Pennsylvania, in its main system of 10,235 miles of highways, has approximately 3,000 miles of such roadways, 6,175 miles of earth and shale roads and 1,060 miles of modern types. This network of roads must meet the universal demand for utility the year round in varying degrees, depending on the locality.

With the change in forms of traffic, there had to be a corresponding change in methods of upkeep. The sporadic maintenance of the yesterdays, when the countryside gathered at convenient intervals on the roads, when it least interfered with their private pursuits, and worked the townships for their taxes, must needs give way to more effective and intelligently directed effort.

Some conception of the volume of traffic on parts of the Pennsylvania State system of roads can be gleaned from the results of a recent traffic census taken on one of the main trunk lines, which showed 40,000 vehicles passing certain given points in 48 hours. This highway is about 380 miles in length and 27 miles of this is the macadam type of road with bituminous surface treatment.

This abnormal use of the highways, which we know is not confined to Pennsylvania alone, must be met with the best skill available if the roads are to be saved. In normal times we probably would have difficulty in justifying some of the things we are compelled to do now, but every possible obstacle and contingency that is likely to arise has to be anticipated and overcome as much in advance of taking up the actual physical operation as possible.

Use of Mechanical Devices

The shortage of labor was met by the introduction of mechanical devices and we no longer see the large road gangs along our highways, for these have been replaced with small crews with equipment adapted to the particular class of work in which they are engaged.

To illustrate this, special attachments to power road rollers have been perfected that can tear up long stretches of road surface and replace them in quick and satisfactory order with but a small organization. When quantities of crushed stone are shipped to justify it, unloading plants are installed at the siding, which handle the materials expeditiously and economically. Motor trucks with dump bodies for the most part have replaced the teams in hauling the materials to the site of the work where a small force is able to put them in place or storage.

The large forces required for spreading covering material on bituminous surface treatment work have been done away with by the adoption of mechanical spreaders drawn by small tractors and trucks, which power can be also utilized for hauling of other kinds when not so engaged.

In the maintenance of earth road sections, fleets of tractors are used to operate the road graders, permitting of the performance of this work at the proper time in the spring to obtain the best results. Light patrol trucks may be used to advantage in dragging such roads during the remainder of the season.

The rigors of winters no longer keep the traveler off the roads, for snow removal work has become a definite and established duty and here again machinery to a large extent has been introduced successfully.

Delivery of Material in Fall and Winter

Materials have been manufactured and delivered on the road through the fall and winter months for the succeeding season's work on the theory that, under such abnormal conditions through which we have passed, a ton of material on the highway was worth many times this amount in the quarry.

Value of Organization and System

A better idea can be had of what can be accomplished under such unfavorable conditions where there is organization and system from the results of the season's maintenance program for this State, shown as follows: Resurfacing, 315 miles; bituminous surface treatment, 1,400 miles; general maintenance solid surfaces, 4,000 miles, and general maintenance earth roads, 6,175 miles.

This program will involve the expenditure of approximately $7,000,000 and the employment of an average force of 4,000 men. In comparison with the year 1917, when approximately the same amount of work was accomplished, we find that in so doing an average of 6,000 men was employed, and after making due allowances, the advantage of modern methods is shown distinctly.

Engineers have been delving into the realms of the unknown and carrying on exhaustive studies and experiments to discover the elixir of life for the modern highway, in order to meet successfully the demands of present day and future traffic, and great strides have been made in the last decade.

I venture to interpose that nothing in the form of highway construction is permanent that is not permanently maintained. Maintenance is one of the neglected arts, for if there was a fraction as much science put into the methods of upkeep of highways as there is in their construction, there would be less economic waste in the country today.

The libraries for engineers are full of treatises and technical works on highway construction but an exhaustive search does not reveal much for the student of maintenance.

This is a time for prudence. There is much educational work ahead for the men who are engaged in this profession if the momentum of highway development is to be kept up.

Times are changing rapidly. The state of mind of our people is slowly but surely returning to its equilibrium. The excesses and extravagances of the recent war era are giving way to more deliberate and sound thinking and demeanor. The vast investments in highways must be protected and conserved to command public confidence and respect if we are to go on. Emergencies, some of which have passed, decreed the construction of many miles of road, which were bought at the market out of bond issues when the purchasing value of the dollar was about 40c.

As values gradually return to normal, if we neglect these highways in the interim or permit them to suffer unintelligent maintenance, I shudder to think of the disastrous effect upon the future of road development if we are called upon to replace them before the maturity of the bonds which must be paid with probably the 90 or 100c dollar, and there is little, if any, salvage from the original investment.

Maintenance Funds

Maintenance is an annual charge and should be paid out of current revenues. The fees from motor vehicle registration seem to be the most logical source from which funds should be derived. Legislation making such appropriations or authorization should be so definite and specific that not a dollar could be diverted to any other purpose. The user of the road is in full accord and a strong advocate of the policy that the money he pays for the use of the highway should go into its upkeep.

WIDTH OF ROADWAYS FOR DIFFERENT CLASSES OF STREETS

By Robert Hoffmann, Commissioner and Chief Engineer, Department of Public Service, City Hall, Cleveland, Ohio

The determination of roadway widths is not a matter susceptible of exact scientific treatment as several rather indeterminate factors enter into it. Doubtless certain rules have been used by some engineers in fixing roadway widths, which, while permitting an appearance of consistency in their work, after all, expressed only their judgment. Under similar conditions other engineers, equally capable, might not have considered such rule applicable, as their judgment of conditions differed.

Some Roadways Too Wide, Others Too Narrow

The subject of roadway widths has been widely discussed and quite fully treated by highway engineers and by writers on municipal matters. Not much that is new can be added, yet a review of the situation is doubtless warranted, especially as affected by the motor driven vehicle. There seems to exist, moreover, a demand for the standardization or classification of roadway widths, so that when certain conditions are assumed the width will be directly determined. This would, in a large way, make possible true economical roadway construction. Economy may be fostered by preventing the building of roadways of excessive widths, thereby saving construction cost, and also in assuring paved ways of ample widths, so as to prevent untimely reconstruction in order to meet the demands of traffic. Frequently one sees pavements which appear altogether too wide for the traffic using them. If any excuse for the apparent excess width existed it must have been the adoption of some arbitrary rule fixing the relation between width of roadway and the distance between property lines. Such wide roadways represent an apparently unnecessary and idle investment. The reverse condition, where roadways are too narrow to permit adequate provision for traffic, is also frequently found. This latter condition is specially manifest in roads where street railway tracks have been laid. Here again the adoption of some arbitrary relation between width of street between property lines and the paved roadway, may have been the cause of building an inadequate roadway, or perhaps the growth of traffic was under-estimated, or the building of the street railway tracks was not contemplated at the time that the pavement was designed. The correction of the difficulty, brought about by providing too small a roadway width,

involves reconstruction or widening, generally at largely increased cost, and in addition an untimely hindrance or annoyance to public travel. Extreme foresight in judging traffic conditions and the adoption of some logically thought out standards seem quite necessary in order to prevent the unsatisfactory conditions just mentioned.

Two Points of View

The determination of roadway widths may be considered from two different points of view. One is from the viewpoint of appearance, governed by rules of proportion, or by making provision for predetermined widths of sidewalk strips or for lawn and parking spaces. The other viewpoint is that of traffic accommodation.

The first viewpoint applies principally to parkways, boulevards and certain classes of residence streets, where beauty and proportion largely control the design rather than economy and utility. Making the roadway from 50 to 60 per cent. of the street width between property lines will, in many cases satisfactorily suit conditions. The design of the planting strips and lawns will, however, nearly always control the width and arrangement of the paved roadways. Even here the expected traffic should receive consideration, but its subordination to other conditions may be perfectly logical and free from criticism.

Consideration of roadway widths from the second viewpoint, that of traffic accommodation, obviously applies to the greater number of cases, and should be the prevailing point of view when considering any basis of design or the standardization of widths.

Financial Aspects

To justify the importance of the subject of roadway widths, it is only necessary to consider the financial side involved. Should the road building programs, that are now being advocated, be brought to the point of construction, it does not seem impossible that for some time to come ten thousand miles of pavement will be constructed yearly. An extra foot in roadway width involves an expenditure of from two to three thousand dollars per mile of pavement under present conditions. For this country's entire road building project, therefore, a sum of from twenty to thirty million dollars becomes annually involved in the addition or rejection of a single foot of roadway width. This represents waste if the extra foot in width is unnecessary and means ultimate economy, if the additional foot will be required by traffic.

Not only is the unproductive investment, caused by an excessive width of roadway, to be deprecated, but, even more so, is the unnecessary removal of labor and material from useful application elsewhere to be regretted. On the other hand too small a width of roadway may result in slowing down the speed of traffic, in causing accidents due to collision or by vehicles being forced off the pavements and in bringing about a general curtailment of the usefulness of the highway. This condition creates a somewhat intangible damage and monetary loss that may far offset an apparent economy in initial investment.

Amount and Character of Traffic

The amount and character of traffic bear an important relation to the width of a road. The total tonnage for a given time or the weight of individual vehicles are of comparatively little importance when fixing the width, as the controlling factors are the size of the vehicles, the speed with which they are to be driven, and the lateral space which must be provided for passing vehicles.

Passenger vehicles as a class may be assumed to have a maximum overall width of 6 ft., while trucks and vehicles, normally used for carrying freight or merchandise over highways do not generally exceed 8 ft. in width. However, there seems to be a natural tendency towards increasing the width of trucks, specially for certain classes of merchandise, which has resulted in a number of places in limiting the size of vehicles by law. So far the maximum width of 8 ft. seems to satisfy existing conditions. The speed of the vehicles affects the clearance which should be left between vehicles when meeting or passing each other. Obviously fast moving cars require a greater clearance for safety than slow ones. Passenger cars consequently should be provided with greater clearance than slow running trucks. A provision of 10 ft. in width as the allotted space for each moving vehicle seems adequate for all cases, provided the maximum width of trucks does not exceed 8 ft. This unit width is larger than was formerly assumed in roadway design but seems justifiable in the interest of safety. Many country highways, providing for two lines of vehicles, have been built narrower than the 10 ft. unit would require, and have served their purpose admirably. Such roadways have been constructed of widths varying from 12 to 18 ft. and when used principally for a moderate number of passenger vehicles have proven quite satisfactory. As the amount of traffic has increased, however, and the number of trucks using the highways has grown, it has been found necessary in many cases to widen the paved roadway in the interest of safety and the expedition of the traffic.

The length of the vehicle as it affects roadway widths is less important except in cases where the use of the vehicle requires its backing to the side of the road in order to load or unload. Many trucks are 25 ft. in length and become a determining feature if their use necessitates backing up to the curb or the side of the traveled roadway.

The kind of load to be carried may also have an influence on the practical width as frequently with light produce or other material, the load is built up so that it extends over the sides of the vehicle. Similiarly, occasional loads extend over the back of the vehicle, as in cases of building material. The frequency with which these exceptional cases occur must be considered and may form a determining feature in certain cases.

Should a roadway be restricted for the use of one line of vehicles only, then the 10 ft. unit could be somewhat reduced. In such case the width need be only such as would accommodate the wheel base with a sufficient allowance to cover the irregularities in steering or driving. Probably 8 ft. in width would suffice. Cases of this kind will seldom occur on public highways and so narrow a roadway would not be justified unless the earth at the side furnished, under normal conditions, a usable road.

On light traffic roads and where the utmost economy must be practiced the single width roadway may be justified, but generally it will be found that the minimum width of paved roadway, acceptable to traffic, must provide for two lines of vehicles, and should preferably be built 20 ft. in width. Here again this assumption can be

modified and the width reduced to as little as 16 ft. when the natural soil conditions are favorable, and admit of an occasional driving off the pavement where forced to do so by some passing vehicle.

For average conditions of traffic, the use of a 10-ft. space for each line of moving vehicles, is suggested as a unit of design. This width applies to street railway cars as well as other motor vehicles. Similarly 7½ ft. may be assumed as the required space for a row of standing vehicles, as when parked along and parallel with the sides of the road.

In fixing roadway widths upon the foregoing basis, the problem lies in assuming the probable number of lines of moving and standing vehicles which must be provided for. Considerable judgment will be required in making such an assumption. The growth of traffic is an element which must be considered and for which no exact data can be obtained. It is well known that the improving of a road by proper alignment, easy grades, and a smooth surface, invites traffic, bringing to such road a far greater number of vehicles than had previously driven over it. With the improvement of the road it will usually be found that new buildings, for homes or industrial uses, will be located along the roadway, bringing with them added traffic in trucks and passenger vehicles. Many occasions will be found for stopping vehicles and allowing them to stand along the way. Should the stopping of vehicles be sufficient to warrant it, an added width must be assumed to provide for the necessary line of standing vehicles. This constantly changing character and extent of use to which a roadway is subject will always make difficult the adoption of the assumption needed for the economical design of roadway width.

Classification for Fixing Widths

In a general way the following classifications may be suggested as a statement of roadway widths in accordance with the foregoing discussion:

(A) City Streets Having Double Street Car Tracks

1. Roadway 75 or 80 ft. in width. A roadway of such width will accommodate on each half, one line of street cars, two lines of moving traffic and one line of standing vehicles; or one line of street cars and three lines of moving traffic. In the latter case the 80-ft. width is preferable. The distance between property lines should be from 106 to 120 ft.

2. Roadway 55 or 60 ft. in width. A roadway of such width will accommodate on each half, one line of street cars, one line of moving traffic, and one line of standing vehicles, or one line of street cars and two lines of moving traffic. In the latter case the 60-ft. width is preferable. The distance between property lines should be from 80 to 100 ft.

3. Roadway 40 ft. in width. A roadway of such width will accommodate on each half one line of street cars and one line of either moving traffic or standing vehicles. The distance between property lines should be at least 60 ft.

(B) City Streets Having No Street Car Tracks

1. Roadway 40, 55 or 60 ft. in width. Same condition as for streets having street car tracks, except that line of street cars is replaced by line of moving vehicles. Absence of street car tracks will frequently permit traffic going in one direction to occupy more than half the roadway. This would be possible when traffic is periodically greater in one direction than the other.

2. Roadway 20 to 35 ft. in width. Residence streets. A roadway of such width will accommodate two to four lines of traffic under different combinations of moving and standing vehicles. The distance between property lines should be 40 to 60 ft.

(C) Highways Outside of Cities

1. Roadway 40 or 55 ft. in width. For traffic between important centers of population. A roadway of such width will accommodate four to six lines of traffic under different combinations of moving and standing vehicles.

2. Roadway 30 to 40 ft. in width. For traffic between centers of population of less importance than the foregoing. A roadway of such width will accommodate three or four lines of traffic under different combinations of moving and standing vehicles.

3. Roadway 20 to 30 ft. in width. For traffic between cities and smaller places or between important smaller cities. A roadway of such width will accommodate two or three lines of traffic under different combinations of moving and standing vehicles.

4. Roadway 16 to 20 ft. in width. Rural highways. A roadway of such width will accommodate two lines of traffic.

5. Roadways 8 to 10 ft. in width. Light country traffic where earth at side can be used to a limited extent.

(D) Streets in Small Towns and Villages

1. Same classification as in cities, except that additional width may be required for standing vehicles where business is concentrated on few streets, so as to permit parking perpendicular or at an angle to the curb. Twenty to 25 ft. for each row of standing vehicles will be desirable in this case.

The foregoing classification must of course be considered somewhat elastic and must be changed accordingly if cars are allowed to park otherwise than parallel with the curb. The question of parking cars upon public streets has an important bearing on the question of roadway widths as it also has upon the control of traffic in general. It must be decided which streets, if any, shall be used for the storage of cars. If the standing of vehicles on the streets is permitted for intervals of possibly longer than an hour, it becomes a problem of storage, and it may be necessary so to design the roadway widths that the greatest number of cars may be accommodated within a limited district. This may require provision for standing cars at an angle to the curb.

The importance of parking regulations entitles it to special consideration and it will not be further touched upon herein, except to note that the adoption of a policy in connection with the parking of vehicles must necessarily have a bearing on the proper widths of roadways.

Conclusion

In conclusion it may be said, that the width of roadways depends upon the size of vehicles, the speed at which they are driven, the lateral clearance between vehicles which should be provided, and the total number which are expected to use the road in a given time, together with their arrangement in lines or rows of traffic. Under average conditions of traffic a width of 10 ft. may

be assumed as satisfactory for each line of moving vehicles, including street cars, and 7½ ft. for each line of standing vehicles parked parallel with the roadway.

The foregoing paper by Mr. Hoffmann was presented at the 1920 annual meeting of the American Society for Municipal Improvements.

EXPERIENCE WITH SURFACE-TREATED GRAVEL, LIGHT-TRAFFIC STREETS IN RICHMOND, IND.

By D. B. Davis, City Civil Engineer, Richmond, Ind.

For towns and cities up to 35,000 population a well constructed gravel roadway surface treated with Tarvia B is a most economical pavement to construct and maintain for residence streets which bear a daily traffic up to 1,000 light weight vehicles.

Gravel, being perhaps the most plentiful and commonest of all materials for street building, has not as some suppose, had its day of usefulness. The recent tremendous increase in the price of other street building materials, due to the increases in freight rates and the labor incident to their preparation for the market, has more than anything else caused road engineers to reconsider the real value of gravel.

With its use for residence street construction proper methods of construction should be followed to get satisfactory results. It is not necessary in most cases that elaborate precautions be taken for crushing and screening the gravel unless the proportion of sizes varies considerable from accepted practice. Crushing and screening to sizes adds much to its cost, thereby eliminating the principal advantages of its use. If maximum sizes predominate, it can be run through the crusher before using, although it is doubtful whether the screening to sizes for the different courses in the pavement warrants the expense if crushed stone is at all available. Acceptable pavements have been constructed from crushed bank-run or ordinary bank-run gravel from the pit with percentages of binder up to 15 per cent.

Tarvia B Surface Treatment in Richmond

Some gravel roadways were constructed in Richmond, Ind., during 1918, which were surface treated with Tarvia B in 1919, which are giving excellent service at the present time. The ordinary methods of construction were used. The old worn gravel surface was first scarified with a 10-ton Huber roller with steam scarifier attached, to a depth of 3 ins. New bank-run gravel was spread thereon to a thickness of about 5 ins. A finished crown of about ½ in. to the foot was attained. After thorough harrowing, the gravel was dampened down and rolled. After once setting it with the roller it was more thoroughly wet and re-rolled to a finish. On the final rolling, the surface was brushed by means of a steel brush attached to the roller. This brushing was instrumental in filling the voids of the larger aggregate and to give the surace a smooth pebble-dash finish.

The Gravel Used

The gravel used in Richmond was from the city's pit and approximated the following screen test:

Passing a 1½-in. screen	100.0%
Passing a 1½-in. and retained on ¾-in. screen	11.7%
Passing a ¾-in. and retained on ½-in. screen	6.7%
Passing a ½-in. and retained on ¼-in. screen	16.9%
Passing a ¼-in. and retained on ⅛-in. screen	17.3%
Passing a ⅛-in. and retained on No. 50 screen	29.4%
Passing a No. 50 screen	4.7%
Clay content	13.3%

The clay appears in the gravel as a coating on the pebbles and not as lumps in the mixture.

Before surface treatments are applied, more satisfactory results have been attained by having the street go through the winter season as traffic therefore has an opportunity to help consolidate it.

Preparation of Gravel Surface

The prepartion of the gravel surface for the application of Tarvia B was as follows: First, all depressions of consequence in that part of the surface which had become compact and hard, were repaired and the former contour of the street restored with a mixture of ¾-in. limestone chips and Tarvia X or K-P, then if the gravel surface had had considerable traffic to compact it, it was swept with a rotary broom to a hard surface and all loose materials removed to the gutter with shovels, where it was later removed by wagons after the application of Tarvia B.

In case the roadway is not thoroughly compact, even through the center, all foreign matter is removed by shovels, but the sweeping is omitted. Sweeping in such a case would loosen the surface particles. Although it does not mean that poor results will be obtained when the surface particles are loose, it does require additional work and care to get the same results as if the gravel was originally hard and smooth.

When the surface has been prepared, the Tarvia B is applied cold by means of a pressure distributor, care being taken that every part of the surface is uniformly covered. For the first treatment from 1/3 to ½ gal. to the square yard is required; subsequent treatments will vary from ¼ to 1/5 gal. per square yard. On the first application no covering is necessary, although for subsequent applications clean chips or pea gravel will add to the endurance of the surface.

Streets which cannot receive a treatment following the initial one should not be treated at all; as it has been demonstrated here that it requires this second treatment to perfect the surface. A street with loose surface requires a second application within one month after the first. Failure is sure to result if this is not done. Take where the surface material is not compact and cannot be swept; shortly after the Tarvia is applied, traffic will disturb the surface to the extent that at certain places in the roadway the untreated gravel will become exposed and it may become dusty. After the initial treatment, it is very important to endeavor to distribute the traffic to all points over the street, to iron out the surface. This has been expedited here by the placing of signs along the street with the words: "Help make a good street. Drive on the side." Whenever the traffic has become general over the entire area, say within a month or so, a second application of ¼ gal. per sq. yd. of Tarvia B is applied.

Tarvia B treated gravel streets in Richmond, Indiana, have required a minimum of maintenance for the above stated traffic census, although we find that it is essential

faithfully to watch them at first and repair at once any breaks which may occur. For this purpose, a maintenance patrol gang, consisting of a one-horse wagon with driver and two helpers, is used. In the wagon is carried ¾-in. stone chips and coarse sand in separate compartments; behind, is drawn a tar heating kettle of Tarvia X. The shallow holes or ruts are repaired by pouring a little hot Tarvia over the surface and spreading a heavy coating of coarse sand over the Tarvia while it is still hot. The deeper holes are filled to within ¼ in. of the surface with ¾-in. chips, smoothed off and tamped, then the hot Tarvia X poured over and around them. One and one-half gallons of Tarvia X is used per square yard of

VIEW OF GRAVEL ROADWAY ON N. 21ST STREET, RICHMOND, IND., AFTER TWO SURFACE TREATMENTS WITH TARVIA B.

patch. Coarse sand is spread over the patch to give it a final finish and make it possible to allow traffic to go upon it immediately.

Should a street a year or so after being treated become subjected to extraordinary traffic or become badly rutted during the winter or spring season, it is scarified, harrowed, reshaped and re-rolled as in the original construction. The old Tarvia B retains its life and mixes with the gravel to the extent that a crust from 1 to 1½ ins. is formed. Soon after, the street is given ¼ gal. per sq. yd. of Tarvia B and covered lightly with pea gravel.

Cost of Patching by Patrol Gang Using Tarvia X

Patches of average depth of 1½ ins. and average area of 4½ sq. ft. The gang makes an average of 88 patches in one-half day.

Labor			
5 hours one-horse wagon at 75c per hour	$3.75		
10 hours 2 helpers at.....60c per hour	6.00		
		$9.75	$.025 sq.ft.
Material			
32 cu. ft. stone chips at	$2.50 per cu. yd.	$2.96	
16 cu. ft. sand at.....	2.00 per cu. yd.	1.20	
70 gal. Tarvia X at...	23c per gal.	16.10	
		$20.26	$.050 sq.ft.
Cost per sq. ft. was $.075		$30.01	

Resurfacing of streets with gravel is done by the street department forces under the direction of the City Engineer and is paid for from the City's General Fund. No expense is incurred by the property owners whatever. The cost for re-surfacing with gravel approximates the following:

Cost of Gravel.

Cost of bank-run gravel at the pit.....	$0.50	per cu. yd.
Hauling by teams, 6 loads per day		
1½ yds. per load, team 75c per hour..	0.84	" " "
Spreading on street at 50c per hour.....	0.16	" " "
Extra man at pit loading at 50c per hr....	0.16	" " "
Cost of gravel on street per cu. yd.....	$1.66	" " "

Cost of Re-surfacing.

Gravel delivered and spread at $1.66.....	$0.37	per sq. yd.
5 ins. finished depth req. 0.22 cu. yds.		
Scarifying and rolling with roller.....	0.08	" " "
Cost per square yard	$0.45	" " "

The Tarvia B is applied by the city forces on petition from the people who reside on the street. Tables of estimates are prepared and kept on file by the Engineer for tarviating each block in the city. These tables of estimates show the width and length of each individual city block, together with the rate of cost per lineal foot and the total cost to the property owners for each block. This amount must be deposited with the city before anv work is started.

Engineer's Estimate for Tarvia B Treatment—One Application of ¼ gal. Per Sq. Yd.

0.003 cu. yds. pea gravel covering at $1.75 per cu. yd...	$.005
Tarvia B F.O.B. track at 12c per gal.....	.030
Estimate per square yard	$.050

As an encouragement to the people, the city has agreed to pay one-third of the cost to the property and all the cost of the intersections.

During the years 1919 and 1920 this city has surface treated 245,000 sq. yds. of street surfaces.

The foregoing paper by Mr. Davis was presented by Mr. Davis at the 1920 annual convention of the American Society for Municipal Improvements.

ASPHALTIC PAVEMENT CONSTRUCTION ON AN ILLINOIS HIGHWAY AND THE CHICAGO BOULEVARD LINK

By John B. Hittell, District Engineer, The Asphalt Association, 29 S. LaSalle St., Chicago, Ill.

For purposes of comparison and perhaps future study it was thought of possible interest to the members of the American Society for Municipal Improvements to present a brief description of two asphaltic types of construction recently designed and constructed, or under construction, and each of which will have a large amount of traffic, said Mr. Hittel in addressing the recent annual convention of the Society at St. Louis.

While there is nothing exceptionally distinct in the designs from the usual yet there is this: in one case a rather unusually rich mix was used in the cement foundation, and in the other an attempt was made to secure a "stiff" top mixture.

The highway or road type was selected because it is the only one, as far as the writer knows, which was contracted for by the Illinois Highway Department during 1919, the other because it is part of the $15,000,000 Boulevard Link improvement in Chicago and hence very likely to be recognized by many at once. The one is suburban with unrestricted traffic of unknown amount and sparsely policed—the other metropolitan with restricted but intense traffic, which at times is all it can carry. Asphaltic concrete and sheet asphalt with binder courses of

equal thickness are placed against each other and future study may throw some important light on the relative value of these paving surfaces.

Asphaltic Concrete

It is the custom of the State Highway Department of Illinois to call for bids on alternate types of construction, viz.: Portland cement concrete and bituminous concrete pavements; sepcifying that the latter, with a wearing surface 2 or 3 ins. in thickness, shall be laid on the same mix of concrete as the cement pavement, with the exception that the concrete for the foundation shall be 1 in. less in thickness than that specified for the concrete pavement.

Federal Aid Project No. 4

In 1919 bids were called for Sections A, B, C and D of project four, Federal Aid, on what is known as the Chicago, Waukegan and Milwaukee Road lying in Cook and Lake Counties—roughly 3 miles in the former and 17 miles in the latter. The R. F. Conway Co. of Chicago. a firm of ample capital and large experience in the construction of all classes of street pavements, and successful in completing several concrete road contracts with the Department, was awarded the contracts on Sections A

METHOD OF ROUGHENING CONCRETE FOR ASPHALT TOPPING ON CHICAGO, WAUKEGAN AND MILWAUKEE ROAD, FEDERAL AID PROJECT NO. 4, ILLINOIS HIGHWAYS.

and B for asphaltic concrete and C and D for cement concrete. The asphalt bids were about $7,200 per mile greater than those for cement concrete. Undoubtedly the authorities in charge desired to avail themselves of an opportunity to make a fair comparison between bituminous and cement concrete highway construction, as the conditions were ideal—the same soil, traffic, widths of roadway, a thoroughly equipped and experienced contractor, and the fact that the asphalt would connect at each end with a cement road.

As its name implies the project, when completed, will furnish a road connecting the manufacturing cities of Chicago, Waukegan and Milwaukee, and very likely is destined to a heavy traffic.

Section A at the south end of the job, comprises 48,507 sq. yds. of pavement, and Section B, which is contiguous, comprises 36,929 sq. yds., and jointly extend a distance of almost eight miles. To avoid repetition hereafter Sections A and B will be spoken of as the road and is the only part in consideration in this article.

The road commences at the village of Techny and runs northwesterly through the villages of Shermerville, Deerfield and Everett. At Techny it connects with a cement concrete road which is 18 ft. in width, 7 ins. in thickness at the sides and 8 ins. in the center; mix 1:2:3½.

The road extends through typical Illinois farming country and in part was an old macadam highway, with the exception of a stretch of about three miles running from Deerfield to Everett, which is new location through farm lands. The old macadam was of varying width and in all instances less than that of the finished road, and on account of the cut is practically of no material value as a support for the pavement. The soil throughout is of clay and drainage is similar to that of other roads built in the State consisting of side ditches, cross culverts, etc.

Grading

During the process of grading long stretches of light cutting were encountered and to facilitate this a large Koehring grader was employed with the result that the operations at times reached the point where 3 yd. wagons were loaded at the rate of 75 per hour. At the end of one of the cuts where a 3-ft. fill was made the soil was such that horses mired themselves and were unable to move their loads. This was overcome successfully by employing a large caterpillar tractor to which was attached three wagons.

Central Mixing

In the first part of 1920 a central mixing plant, consisting of two four-bag mixers, was installed for mixing concrete, which was then hauled in trucks for a distance of 2½ miles and deposited on the grade. This system proved successful during the early stages of the work but had to be abandoned later owing to the inability of the material producers to supply the quantity of materials necessary to operate the mixers simultaneously.

Use of Light Trucks

At the present writing (August, 1920) concrete is being laid south from the village of Everett. The materials for the concrete are hauled in bodies mounted on a Ford chassis, a body being sufficiently large to contain one batch of four bags of cement, sand, and stone in the proportions of 1:2:3½. The truck is first loaded with four bags of cement from the pile or car, then to the sand car where the sand has been previously shoveled into a box attached to the side of the car from which it is emptied into the truck. This box is readily moved from one point to another on the side of the car, and is sized to hold twice the portion of cement. The necessary amount of coarse aggregate is added and is gaged by the size of the body. About 25 of these trucks are employed, and being equipped with 4½-in. tires on the rear wheels, very materially help to compact the subgrade. In fact the District Engineer of the State Highway Department advised me that there is practically no rolling of the fine grade. The line and grade is maintained by steel forms and exact subgrade secured by a strike board drawn along the same. The condition of the subgrade is excellent.

The concrete is 6 ins. at the sides and 7 ins. at the center and the difference makes the crown for the finished pavement. On tangent lines the subgrade is flat. The State 1920 specifications call for cement concrete

pavements to be uniformly 8 ins. in thickness with a crowned subgrade, and 7-in. foundation for bituminous pavements.

Superelevation

On curves the superelevation is as follows—the width being 18 ft.:

6° 30′	15″
6	13¾
5 30	12⅜
5	11¼
4 30	10⅛
4	8¾
3 30	7⅜
3	5⅞
2 30	4⅜
2	2½

The rise on curves of 7 degrees (about 800 ft. radius) or less, is 1 in. per foot of width.

The maximum gradient is not over three per cent., except at bridge approaches where it is 4½ per cent.

The concrete at the time observed was not as stiff as might be expected but the inspector explained this was due to the excessively hot day and the fact that the gravel was running a trifle small. With a change of gravel this condition was remedied. A Lakewood mechanical tamper has been used but at the time stated compression was obtained by a large wooden tamper operated by two men, one at each side of the roadway.

Curbing

In the specifications originally no curb was provided for the bituminous surface, but wisely through an agreement between the contractor and officials a curb 4 ins. in width and about 3 ins. in height is being built integrally with the foundation. The height is a trifle less than 3 ins. in order that the wearing course may be thoroughly compacted at the edge of the curb. The average progress of the concrete foundation with curbing is over 400 ft. per day.

Rough Rolling

Last fall when the work was first started brooms were used to roughen the surface of the concrete, but this method was very shortly superseded by the hand roller shown in the accompanying view. This roller was designed by Mr. G. N. Lamb, District Engineer of the State Highway Department, and consists essentially of 5 ft. of 10-in. wrought iron pipe sealed at both ends, to which has been attached at intervals of 5 ins. ordinary 1-in. angle irons. The roller is operated by two men, one on each side of the roadway and corrugations are made roughly at an angle of about 60 degrees both to the right and left of the center line of the road leaving the surface roughly "diamond" shaped. The result is very satisfactory. Curing of the concrete is secured by the use of wet tarpaulins and flooding afterwards. No earth is used for this purpose as it is not considered possible to remove it afterwards from the rough concrete in a satisfactory manner.

Four thousand feet of finished roadway was laid in 1919. The concrete was started on Sept. 24th, while the binder and top was laid during the week of Nov. 20th. Owing to the lateness of the season the contractor ran these materials from his Elston Ave. plant in Chicago, hauling it in 7½-ton trucks a distance of 17 miles. The penetration varied between 56 and 68. Inspection was had by the State at the plant, on the work and by its laboratory at Springfield.

To finish this year more than seven miles of binder and top the contractor has installed at Deerfield a one car Cummer plant of capacity of approximately 200 tons or 700 lin. ft. of completed bituminous work. The hauling will average two miles. Two tanks of about 18,000 gal. capacity, one for fuel oil and one for asphalt cement, will be used to guard against intermittent supply of these materials.

Asphalt Requirements

The specifications gave the bidder the latitude of selecting an asphalt of any of the well known brands as well as tar for the bituminous cement, and the option of bidding with or without a binder course. He chose the binder course and bid on an asphalt meeting the following requirements:

Specific gravity 25°C./25°C. (77°F. 1.020 to 1.060).
Flash point not less than 177°C. (350°F.)
Ductility at 25°C. (77°F.) not less than 100 cm.
Penetration at 25°C. (77°F.), 100 gm., 5 sec., 55 to 75.
Loss at 163°C. (325°F.), 5 hours, not over 2.0%.
Penetration of residue at 25°C. (77°F.), 100 gm., 5 sec., not less than 30.
Total bitumen, not less than 99.5%.
Per cent of total bitumen insoluble in 86°B. naphtha 15.0 to 29.0
Fixed carbon, 9.0% to 17.0%.

The mixer for the binder course shall be composed of asphaltic cement or tar, stone chips and fine aggregate. The materials shall be so combined that the mixture shall contain average proportions by weight as follows:

Bitumen	4½% to 6½%
Mineral passing 10 mesh	15 % to 30 %
Mineral passing 2 mesh and retained on 10 mesh	40 % to 70 %
Mineral passing 1 mesh and retained on 2 mesh	10 % to 30 %

The mixture for the wearing course shall be composed of coarse aggregate, fine aggregate, filler and asphaltic cement or tar. The materials shall be so combined that the mixture shall contain average proportions by weight as follows:

Bitumen	7½% to 9%
Mineral passing 200 mesh	7% to 10%
Mineral passing 40 mesh and retained on 200 mesh	20% to 30%
Mineral passing 10 mesh and retained on 40 mesh	25% to 35%
Mineral passing 4 mesh and retained on 10 mesh	8% to 22%
Mineral passing 2 mesh and retained on 4 mesh	0% to 10%
Mineral passing 2 mesh and retained on 10 mesh	18% to 32%

No guarantee is required.

The construction of this asphaltic road and the connecting cement road by the same contractor, and under conditions as equal as can be had, will give an exceptional and excellent opportunity for the observation of the effect which different factors have upon the life and service of a pavement. Many engineers believe that this foundation is needlessly expensive.

Traffic Notes

The beginning of the road is 19 miles from the City Hall in Chicago. On Sunday, Aug. 8th, and Monday following, Mr. Geo. A. Quinlan, County Superintendent of Highways, took a count of the traffic on Milwaukee Ave. between Dempster St. and Ballard Road, a point located 15 miles from the Hall. The results are as follows:

SUNDAY

TIME	Pleasure Cars	Motor Trucks	Total	Weather
12 P. M. to 1 A. M.	130	7	137	Fair
1 A. M. to 2 A. M.	43	2	45	Fair
2 A. M. to 3 A. M.	160	2	162	Cloudy
3 A. M. to 4 A. M.	142	2	144	Cloudy
4 A. M. to 5 A. M.	66	—	66	Rain
5 A. M. to 6 A. M.	78	—	78	Rain
6 A. M. to 7 A. M.	40	—	40	Clear
7 A. M. to 8 A. M.	280	20	300	Clear
8 A. M. to 9 A. M.	200	11	211	Clear
9 A. M. to 10 A. M.	391	28	419	Clear
10 A. M. to 11 A. M.	567	63	630	Fair
11 A. M. to 12 N.	500	45	545	Fair
12 N. to 1 P. M.	500	51	551	Fair

1 P. M. to 2 P. M.	394	19	413	Fair
2 P. M. to 3 P. M.	513	17	530	Fair
3 P. M. to 4 P. M.	757	16	773	Fair
4 P. M. to 5 P. M.	1000	15	1015	Fair
5 P. M. to 6 P. M.	1027	29	1056	Fair
6 P. M. to 7 P. M.	1126	45	1171	Fair
7 P. M. to 8 P. M.	1207	70	1277	Fair
8 P. M. to 9 P. M.	1148	61	1209	Fair
9 P. M. to 10 P. M.	709	23	732	Clear
10 P. M. to 11 P. M.	294	11	305	Clear
11 P. M. to 12 M.	179	3	182	Clear
Grand Total			11,991	
MONDAY				
12 M. to 1 A. M.	86	2	88	Fair
1 A. M. to 2 A. M.	28	1	29	Fair
2 A. M. to 3 A. M.	18	—	18	Fair
3 A. M. to 4 A. M.	23	2	25	Cloudy
4 A. M. to 5 A. M.	34	—	34	Cloudy
5 A. M. to 6 A. M.	48	5	53	Cloudy
6 A. M. to 7 A. M.	53	7	60	Cloudy
7 A. M. to 8 A. M.	135	21	156	Cloudy
8 A. M. to 9 A. M.	95	5	100	Fair
9 A. M. to 10 A. M.	121	21	142	Fair
10 A. M. to 11 A. M.	137	20	157	Fair
11 A. M. to 12 N.	102	20	122	Cloudy
12 N. to 1 P. M.	93	18	111	Cloudy
1 P. M. to 2 P. M.	90	13	103	Cloudy
2 P. M. to 3 P. M.	110	17	127	Cloudy
3 P. M. to 4 P. M.	110	13	123	Cloudy
4 P. M. to 5 P. M.	152	19	171	Pt. Cldy
5 P. M. to 6 P. M.	168	27	195	Cloudy
6 P. M. to 7 P. M.	102	19	121	Cloudy
7 P. M. to 8 P. M.	203	20	223	Cloudy
8 P. M. to 9 P. M.	288	15	303	Cloudy
9 P. M. to 10 P. M.	112	7	119	Clear
10 P. M. to 11 P. M.	86	6	92	Clear
11 P. M. to 12 M.	48	1	49	Clear
Grand Total			2,721	

The percentage of motor trucks of all vehicles was 5 minus on Sunday and 10 plus on Monday. Neither of these days of the week was probably as good as any of the remaining five days to ascertain the amount of truckage since business is generally suspended on Sunday. Deliveries are usually from the city on Monday's orders, and farm produce is seldom loaded on Sunday for Monday delivery. Trucks to all motor vehicles is 12.6 per cent. in the State and 20.1 per cent. in Chicago.

Speed and Weight Regulations

The Illinois Motor Vehicle Law provides that the weights shall be limited as follows:

The maximum gross load to be permitted on any axle of any vehicle shall not exceed 16,000 lbs.; and the gross weight of any vehicle, including the weight of the vehicle and maximum load, shall not exceed 800 lbs. per inch of the average width of tire of the road wheels of such vehicles in actual contact with the surface of the road.

Weight limits 50 per cent. above those provided for herein may be permitted by ordinance in cities having a population of more than 20,000, but such increase shall not apply to vehicles when outside the limits of such a city.

SPEED LIMITS

Weight of Vehicles and Load	Pneumatic Tires	Two or More Solid Tires
5,000 lbs.	25 mi. per hr.	20 mi. per hr.
5,000 lbs.—not more than 12,000 lbs.	20 mi. per hr.	15 mi. per hr.
12,000 lbs.—not more than 15,000 lbs.	15 mi. per hr.	12 mi. per hr.
More than 15,000 lbs.	12 mi. per hr.	12 mi. per hr.

Permits may be issued for specially heavy loads or vehicles. When frost is leaving the ground, officials may on a definitely designated highway, prohibit the operations of vehicles having a gross weight, including weight of vehicle and load, of more than 5,000 lbs., by posting notices along such road. The entire time of such embargo shall not exceed 45 days in any one year.

Highway Patrol Work

The County Superintendent of Highways has a force of about 12 men who are assigned to patrol about 200 miles of the most important highways in Cook County.

The offenses which occur most frequently are such as a driver keeping his vehicle in the center of the road, vehicles parking on paved highways to make repairs or to purchase vegetables, vehicles turning from the main highway and stopping on a comparatively untraveled cross road with turned off lights, and the usual offenses against speeding and reckless driving. In the springtime when the frost is coming out particular attention is given to over-loading of trucks, and this menace was very well corrected after a thorough conference among parties interested. This offense is committed chiefly by trucks hauling building material. This hauling is generally done by individuals or firms owning trucks for the large producers of building supplies. The owner is not the responsible party as the driver benefits in pay by handling exceptionally heavy loads. The need of enforcing the law on this point is necessary on account of the condition of the culverts and bridges which have been built for quite a number of years.

Sheet Asphalt on Boulevard Link

The sheet asphalt pavement on the north and south approaches to the new Boulevard Link Bridge, and laid in connection with the widening and extension of Michigan Ave. and Pine St., from Randolph St. to Chicago Ave. will be observed by all that have an opportunity and are interested in pavements.

This improvement consisting of condemnation of lands and buildings on a frontage of ¾ mile, adjusting underground facilities, constructing sewers, sidewalks, electrical lines, depressing intersecting streets, building lower and upper level roadways for commercial and pleasure traffic, erecting a double Bascule bridge with two leaves, each 170 ft. long, is a magnificent work of credit to all concerned.

The roadways on Michigan Ave. and Pine St. formerly were 38 ft. in width, and all continuous traffic passing over them crossed Rush St. bridge, which had two roadways, each 17½ ft. wide. The roadway of the new bridge is 54 ft. wide—the south approach and the north approach roadways are respectively 75 and 80 ft. in width.

As soon as rights to the property were obtained and the obstructions removed, work preliminary to paving was commenced. The stretch of paving from Chicago Ave. to Ohio St., covering 17,850 sq. yds., was paved between July 25th and Oct. 15th, 1918. The remaining asphalt pavement on the north and south approaches—progress of which was dependent on the iron work—was finished early this year.

The rehabilitation of underground service and installation of new ones, the old basements and sidewalk subareas, required special care in preparing a foundation for the pavement, and the specification wisely provided for sand filling where directed by the Board of Local Improvements.

The paving specifications were: Concrete base 8 ins. in thickness, mixed in proportion of 1:3:6. Binder course 1½ ins. in thickness, composed of stone varying in size from 1 in. downwards, sand and bitumen, resulting in mixture containing 4 to 7 per cent. of bitumen, and from 20 to 30 per cent. of material passing a 10 mesh screen.

The surface mixture and a test of one batch as follows:

	Specifications	Test	Composition
Bitumen	10-12	10.5	Trinidad 76%
sieve	15-20	18.0	
Sand passing 80 mesh sieve	20-30	21.6	
Portland cement and mineral matter passing 200 mesh			I. R. C. 24%
Sand passing 40	20-40	38.2	Penetration 40
Sand passing 10	8-20	10.5	
Sand passing 4	5-10	1.2	

The gradient on the approaches is under 2 per cent. and most of the work is on a level grade. On level stretches the crown on the 80-ft. roadway is 10 ins. with a parabolic curve; on gradients this was reduced to 9 ins. The reasons for these flat surfaces probably were to accommodate traffic comfortably near the curb lines, coupled with the assurance that these roadways being boulevards would be kept clean.

Guarantee

It is understood and agreed that all labor and material shall be of such character that the entire work shall be and remain in good condition during the entire period of one year, except that for all pavements the period shall be two years, from the acceptance of the work, and the contractor hereby agrees to keep in perfect repair, during such period, the whole of his work, except in cases where the repairs may be rendered necessary by causes clearly beyond his control. The keeping and maintaining of said improvement in continuous good order and condition for the above mentioned period shall include all repairs to be made, or if necessary the entire reconstruction of the work as said Board of Local Improvements may direct, without any additional charge or cost to the City of Chicago, except as hereinafter provided.

As a basis for the interpretation of the satisfactory condition of the pavement during the period of the guaranty and at the expiration thereof, it is hereby agreed and understood that if the foundation and binder are sound, and the entire wearing surface of the roadway shall possess a minimum thickness of 75 per cent. of the original specified wearing surface and be in a smooth condition for travel and shall be free from cracks which show indications of disintegration of the wearing surface, it shall be considered as meeting the requirements of said guaranty.

To enforce this guarantee 5 per cent. of the cost of the pavement is retained and upon which interest is paid. One-half is returnable at the expiration of one year.

The improvement was made solely to accommodate pleasure car traffic between the two sides of the river and to provide separate roadways for commercial traffic to and from the railroad freight yards.

Traffic Notes

The number of cars is very large and during the rush hours of the morning and evening the entire roadway is covered. Speeds of 25 and 30 miles per hour are common at these times and are not opposed by the officers policing the road.

The Chicago Motor Bus Co. operates a line of busses of two types weighing empty 10,500 and 11,500 lbs., having an allowable ordinance capacity of 50 and 60 persons respectively. Application to use a type carrying 60 passengers and weighing 12,500 lbs. has been made to the authorities and one of this class is now operating under temporary permit.

By ordinance the schedule interval, except at midnight, is not more than 20 minutes "or satisfactory service." In fact the rush at morning and evening intervals is about 2 minutes and during the rest of the day 10 minutes. The rate of speed ranges from 15 to 20 miles per hour. Genuine co-operation has prevailed among the company's officials and the authorities, with the result that the destructive effect of this traffic on the pavement has been reduced.

AUTOMOBILE COUNT AT PEARSON ST. (200 FT. NORTH OF CHICAGO AVE.) AND NORTH MICHIGAN AVE. SUNDAY, FEB. 29, 1920

10 A. M. to 7 P. M. Tem. 60°

10 to 11	400
11 to 12	550
12 to 1	750
1 to 2	900
2 to 3	1,150
3 to 4	1,550
4 to 5	1,700
5 to 6	1,300
6 to 7	1,100
	9,400

AUTOMOBILE COUNT AT LAKE SHORE DRIVE (N. MICHIGAN AVE.) AND OAK ST. (1,300 FT. NORTH OF CHICAGO AVE.) SUNDAY, JULY 25, 1920

12 Noon to 7 P. M. Tem. 60°

12 to 1	900
1 to 2	1,300
2 to 3	1,700
3 to 4	2,300
4 to 5	2,500
5 to 6	2,100
6 to 7	1,900
	12,700

The B. F. Goodrich Rubber Co. on Wednesday, August 11, 1920, took a count of the traffic at Michigan Ave. and Jackson Blvd., a point about six blocks south of Randolph St., as follows:

Time	No. Bound	So. Bound	Total
7 to 8 A. M.	574	786	1,360
8 to 9 A. M.	1,444	1,702	3,146
9 to 10 A. M.	1,635	1,668	3,303
10 to 11 A. M.	1,655	1,422	3,077
11 to 12 M.	1,526	1,461	2,987
12 to 1 P. M.	1,329	1,407	2,736
1 to 2 P. M.	1,523	1,521	3,044
2 to 3 P. M.	1,556	1,744	3,300
3 to 4 P. M.	1,740	1,717	3,457
4 to 5 P. M.	1,783	1,845	3,628
5 to 6 P. M.	1,942	1,978	3,920
6 to 7 P. M.	1,405	1,302	2,707
	18,112	18,553	36,665
Average per hour	1,509	1,546	3,055
Average per minute	25	25	50

The traffic of the rubber tired motor truck, heavily loaded and moving rapidly, together with the nearly total abolition of steel tired vehicles, has changed the wear on roadway surfaces mostly from attrition to distortion under impact. The impact tests now being conducted by the Bureau of Public Roads to determine the amount of impact delivered to road surfaces, and the effect of this impact on different types of surfaces are timely and of great value. With customary speeds and loads these impacts have been shown to be very heavy and pavement surfaces in the future must be made as near uniform as possible and be composed of tough materials. With the cushioning effect of rubber acknowledged, the tests showing the cushioning effect of bituminous paving surfaces will be awaited with great interest.

The curve of number of motor vehicles in the United States, including the District of Columbia from 1913 to 1919 was practically a straight line. A change from present economic conditions which is thought imminent may change the trend of the curve due to a lesser increase in the number of passenger vehicles. Trucks will increase and the truck owner is vitally interested in the construction and preparation of good roads. If he persists, however, in carrying excessive loads at high speed there can be but one result—drastic laws rigidly enforced. The

two instances referred to in this article show that co-operation is better at times than legislation. If or not prescribed to weight and speed, the truck owner is conscious that he is contributing financially in a large way to road construction, and will voice a demand for a type that will make operation and maintenance of trucks the most favorable to him.

Surfaces in use today may be characterized as rigid, and flexible or resilient. A smooth, flexible, resilient surface reduces the amount of tire wear and the stresses due to motion in the mechanism and structure of the vehicle. When "favorableness to motor vehicles" becomes a factor, as it shortly will, in determining the selection of a type of construction, the bituminous pavements combining smoothness, flexibility, and resiliency have decided advantages on this score over other types.

For data and information the writer is indebted to Mr. G. N. Lamb, District Engineer of the State Highway Department of Illinois, Mr. Geo. A. Quinlan, Superintendent of Highways, Cook County, Ill., and representatives of the R. F. Conway Co., and which is here gratefully acknowledged.

SURFACE TREATING STREETS WITH LIQUID ASPHALT IN WALPOLE, MASS.

By E. F. Durfee, Superintendent of Streets and Town Engineer, Walpole, Mass.

One of the paramount problems with which a highway engineer is confronted is the selection of the proper material for certain work. In this connection there is a possibility of two mistakes. An inexperienced engineer may choose a material which does not come up to the requirements; or he may select a material which would exceed the needs of the particular street. In the first case true economy is not practiced because the road will soon need a second treatment. In the second case the

MEDFIELD STREET, WALPOLE, MASS., GRAVEL TREATED WITH TEXACO NO. 55 ROAD OIL.

difference between the cost of the proper material and the selected type is a pure loss.

Walpole, Mass., was confronted with just such a problem. Several of the streets in the town were in a deplorable condition. Incessant traffic had developed pot holes and ruts which were difficult to repair. The town originally had planned to construct some type of permanent construction, but owing to lack of funds the thought was abandoned. It finally was decided to employ liquid asphalt in surface treating the roads.

The first step in the work was to fill all depressions in the road with gravel. When traffic had been permitted on the road for a time, the gravel was treated with Texaco Liquid Asphalt. Sand was spread over the patches to absorb all surplus asphalt. For a week the

ROAD IN WALPOLE, MASS., TREATED WITH GRAVEL AND TEXACO NO. 55 ROAD OIL IN 1919.

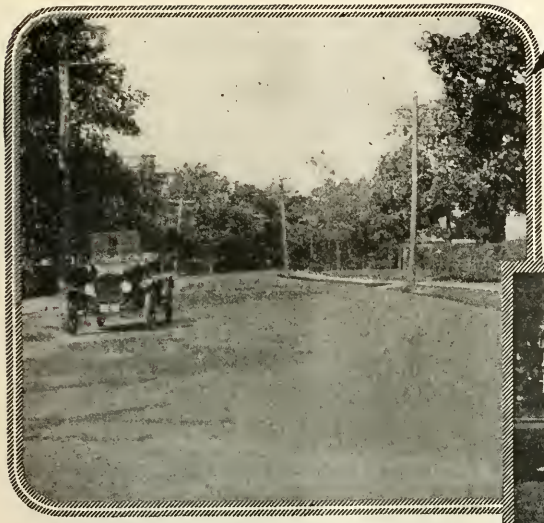
street was opened to traffic, which served to level off and thoroughly consolidate the patching. Then the entire road was gone over with a road drag to bring it to uniform grade and contour. This completed, it was ready for the application of the main treatment of asphalt.

Texaco Liquid Asphalt No. 1 was distributed by truck at the rate of 1/3 to ¼ gal. per sq. yd. The work of spreading the oil was facilitated by heating the material to a temperature of 150 degrees Fahrenheit. The liquid asphalt was covered immediately with fine gravel at the rate of 20 lbs. per sq. yd.

Finally the road was raked to remove all large stone and a roller was run over the street to crush the remaining stone. The liquid asphalt and gravel mixture formed a mat ¼-in. thick, which greatly reduced the disintegrating effect of traffic.

Every two weeks the street receives a thorough inspection, all weak spots being reinforced; in this way the life of the pavement is increased. The roads in Walpole treated in this manner are standing up under traffic as well as a more permanent type of construction.

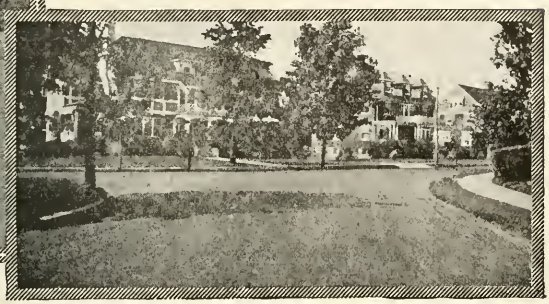
The cost of the work might prove useful to engineers who contemplate using liquid asphalt in surface treating their highways. The oil applied cost 14¾ cts. per gallon.



Everett Avenue, Winchester, Mass., built with "Tarvia-X" in 1915. The avenue is a clean, durable, easy-traction roadway maintained at a minimum expense.

Tarvia

Preserves Roads Prevents Dust



Sheffield Road, Winchester, Mass., a macadam road kept in perfect condition by an occasional treatment with "Tarvia-B".

Tarvia Roads cost *less* than untreated roads—

"OUR uniformly clean streets are the pride of the town and *Tarvia is responsible for this condition.*"

So writes Mr. T. Parker Clarke, Superintendent of Highways, Winchester (Mass.), who has been using Tarvia extensively ever since 1908, both for gravel and waterbound macadam roads and streets.

The saving in maintenance has been so considerable since the use of Tarvia that instead of spending all his appropriation on the streets in the central part of the town, he is able to take care also of *many outlying districts which formerly were entirely neglected.*

This is another striking proof of the fact that it is actually cheaper to treat your roads and streets with Tarvia than to leave them untreated.

The small extra first cost is quickly balanced by the saving in repair bills and this saving gets bigger every year because Tarvia roads do not wear out as do untreated roads, but only require an occasional surface treatment to keep them in excellent condition.

Tarvia is a coal-tar preparation, low in cost and easily applied, which renders your roads dustless, mudless, frost-proof and automobile proof. Tarviated roads are the one economical solution of the problem of high-grade low-cost roads for cities, towns and country districts.

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.

Illustrated booklet telling about the various Tarvia treatments, free on request.

New York Chicago Philadelphia Boston
Detroit New Orleans Birmingham Kansas City
Salt Lake City Seattle Peoria Atlanta Duluth
Lebanon Youngstown Toledo Columbus
Buffalo Baltimore Omaha

The Barrett Company

St. Louis Cleveland Cincinnati Pittsburgh
Minneapolis Dallas Nashville Syracuse
Milwaukee Bangor Washington Johnstown
Richmond Latrobe Bethlehem Elizabeth
Houston Denver Jacksonville

THE BARRETT COMPANY, Limited: Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S. Sydney, N. S.

The sand placed in piles every 20 ft. along the road cost about $1 for 2,750 lbs.

Sixteen men and a foreman and a 3-ton truck were required to cover the oil with sand. The truck was used to cover any place where the sand ran short or where pools of oil showed after the sanding gang had passed on. This size gang was able to cover about 4,000 gal. of oil per day of eight hours.

The steam roller would have been standing idle at this time, so no charges were made for its use.

Three one-horse carts and four men were used to rake off the stone. The gravel ran about 15 per cent. stone over ¾-in.

THE RELATION OF HOUSING TO ENGINEERING

(Editor's Note: The following discussion of The Relation of Housing to Engineering is the text of the report of the Housing Committee of the Sanitary Engineering Section of the American Public Health Association as presented at the 1920 annual convention of the Association. Mr. Morris Knowles, of Pittsburgh, was chairman of the Committee and the other members were: John W. Alvord, of Chicago, W. C. Folsom, of Cincinnati, George A. Shaw, of Philadelphia and Mr. Groeniger, of Columbus, Ohio).

Of all the reconstruction problems which have followed in the wake of the war, none has attracted more general interest or has pressed upon a larger proportion of the people than the housing problem. The shortage of homes is world-wide. Cessation of house building during the war, together with the growth of population, especially in industrial centers, have resulted in a deficiency below actual needs, which has been estimated, for the United States, at about two million homes. At the same time, the great increase in construction costs, the difficulty of financing new construction, the lack of incentive to private builders arising out of the lag in rents behind construction costs and the general uncertainty of the situation, have broken down the economic machinery by which the need for homes is ordinarily supplied. Extraordinary measures have therefore appeared to be required, and government housing and loans to home builders have become established policies in Great Britain, Canada and elsewhere. In our own country, we have seen millions expended in government housing during the war by the United States Shipping Board and the United States Housing Corporation; and within the past year "home loan bank" legislation has been considered, both in Congress and in the legislatures of several of the states.

Under these conditions, it is most appropriate that the Sanitary Engineering Section of the American Public Health Association should have appointed a Committee on Housing, and that consideration should be given at this time to the relation of housing to engineering.

Development of Problem

The housing problem, growing out of the concentration of population in cities which resulted from the growth of industry under the factory system, first evidenced itself in the development of unsocial and insanitary home conditions. It is natural, therefore, that the first efforts at its solution should have taken the form of exposure of these evil conditions and of criticism of their effects. This led naturally to the second phase of the attack on the problem, namely, the elimination of such conditions by governmental regulation and the adoption of restrictive legislation fixing minimum standards for light, air, sanitation and convenience. In all of these matters, sanitary engineers have performed, and are still performing, notable services.

The housing problem of today, however, is a problem of planning and construction, and in its solution the engineer has a so much wider field of activity and so much greater responsibility and opportunity than at any preceding stage of the development of the problem, that it seems desirable to confine the remainder of this brief report to a consideration of the relation of engineering to the present-day problem of housing construction.

Professional Co-operation

It is of course true that engineering is only one of the professions that must be drawn upon for the solution of the housing problem. Any solution that is of value must result from the co-operation of the landscape architect, the engineer, the architect, the sanitarian, the constructor, the realtor and the public-spirited citizens of the community. The part played by the engineer, however, is not generally enough recognized or understood. This summary statement, therefore, will serve a useful purpose if, while emphasizing the need of co-operation, it can contribute to better appreciation of the extent to which the problem is an engineering one.

Organization and Finance

Under present conditions, one of the most difficult steps in the solution of the housing problem is the organization and financing of housing construction. To this problem the engineer can apply his training in fundamental economics and comparison of values in such a manner as to be of as much service as any other citizen. It is also essential to the success of a construction program that a definite policy of "quantity production" be inaugurated from the beginning and be made the basis of the financial and organization plan. For this consideration, the engineer is, of course, especially well qualified. In these stages of the problem, the engineer is more likely to be interested as a public-spirited citizen rather than as a professional advisor, and yet in view of all the effort now being made to enlarge the civic activities of the profession, it does not seem inappropriate to call attention at this time to this field of opportunity for the engineer in connection with housing.

Selection of Site

Where houses are to be constructed in groups, the proper selection of sites is of vital importance, and the services of engineers are necessary in connection therewith. The relation of the locations of available sites to existing and prospective industries; the suitability of sites with respect to topography, soil conditions, climatology and existence of nuisances; the available means of communication and transportation; as well as the comparative estimated cost of development on different sites, are all factors in the consideration of which engineering principles must govern.

(Continued on page 221)

WATER WORKS SECTION

WATER RATES IN SMALL CITIES AND VILLAGES

By John Wilson, Consulting Civil and Sanitary Engineer, 300 First National Bank Bldg., Duluth, Minn.

According to the latest information the writer has at hand, there are 202 water works plants in the State of Minnesota, of which 195 are publicly owned and 7 privately owned. In view of the foregoing, the Minnesota Section of the American Water Works Association will be interested in water rates which apply particularly to municipally owned plants, said Mr. Wilson in addressing the recent annual convention of the section.

A municipality when operating a water works system is engaging in a commercial enterprise; and to be successful, it must furnish adequate service at reasonable rates, which must be in proportion to the service rendered and without discrimination.

Two Types of Service

The service rendered by a water works plant is of two distinct types; first, it must be ready to furnish water in comparatively large quantities under high pressure for short periods of time for the purpose of extinguishing fires; and second, to furnish ample quantities of suitable water for domestic purposes under moderate pressure at all times.

It is now generally conceded that all the expenses incident to the former should be borne by the village or city at large. It is possibly unfortunate that the method of arriving at the compensation for fire service has generally taken the form of hydrant rental, as the number of fire hydrants has but a remote relation to the value or cost of the service.

It has been estimated that 60 to 80 per cent. of the cost of water works plants in cities under 5,000 is incurred by providing reasonable fire protection.

Rate Determination at Crosby, Minn.

Two years ago the writer was called on to report on the matter of rates for the village of Crosby, Minnesota, which problem involved some unusual and interesting features.

Crosby has a population of approximately 3,500, and owes its existence largely to iron mining industries in the immediate vicinity.

The water works plant was installed in 1911 by a private company, and operated by them until two years ago, when taken over by the village.

The franchise under which the company operated provided, in case the village wished to acquire title to the plant, that a board of appraisers should be appointed to determine the value and price to be paid. In accordance with this provision, Mr. C. T. Harding, of Virginia, was selected by the company, the writer was appointed by the village and Mr. John W. Alvord, a past president of the American Water Works Association, was selected as the third member. The value of the plant, as fixed by the board was $75,680.

The plant at that time consisted of twelve ground water wells 70 to 80 feet deep, electrically driven centrifugal pumps, a 100,000 gal. elevated tank, about six miles of distributing mains 4 to 10 in. in diameter, and 34 fire hydrants.

The conditions which led up to the village taking over the plant were largely due to failing of private wells, due to mining operations, and many of the outlying districts were entirely deprived of water, the company in the meantime was naturally very reluctant to make extensions.

Immediately upon taking over the plant the village spent over $56,000 in extending the distributing mains and also installed 35 additional fire hydrants.

The first step in determining what would be a fair schedule of rates was to estimate the proportion of the cost of the plant chargeable to fire protection. It was accordingly estimated that 51.6 per cent. of the appraised value and 45.9 per cent. of the cost of extensions might justly be charged to fire protection and the remainder charged to commercial service.

The village had 356 consumers and 155 householders who had asked for connections as soon as the extensions could be completed.

The question naturally came up as to who should install the meters and lay the connection from the main to the curb box.

In connection with this, the writer suggested that the village assume the cost of these two items, inasmuch as the number of consumers was small compared with the amount of distributing main; that many of the householders were men of limited means, who would be tempted to carry water rather than connect with the mains were they required to bear all the expense; and, furthermore, one of the principal needs of the water department was paying consumers. It was also suggested that, in consideration of the village bearing this expense, all consumers should pay a service charge sufficient to cover the interest on the necessary investment and depreciation.

Authorities Cited

In support of these suggestions, he quoted the following authorities.

In the case of Samuel M. Gillmore vs. Hackensack Water Company, the New Jersey Public Utility Commission ruled as follows:

> The Board concludes that the Hackensack Water Company should take upon itself the burden of maintaining all such connections as lie within the public streets up to and including the stop cock.
>
> The practice of the company, requiring the consumer to pay for the installation of service pipe within

Printed as Insert to MUNICAPAL AND COUNTY ENGINEERING, Chicago, Ill., December, 1920.

the public streets and the stop cock, is disapproved as an improper and unreasonable charge.

Dated Dec. 7, 1915.

A similar ruling by the Wisconsin Railroad Commission was as follows:

The question as to who should own meters appears to be settled. The only point to be decided here is whether or not services are a part of the facilities which the utility is expected to furnish. The logical conclusion seems to be that the utility should install and own services to the curb line. The utility, and not the consumer, has the right to occupy the streets, and all pipes laid in the streets should be the property of the utility, and we believe should be put in by the utility. The business of the utility is to deliver its product to the premises of the consumer. If the utility should own the mains through which water is carried to various sections of the city, it seems equally true that it should own all parts of the distribution system as far as the consumer's premises. The service pipe from main to curb is as much a part of the utility's distribution system as is the main itself. Both parts of the equipment have the same purposes—the delivery of water to the consumer's premises.

The California Railway Commission reached the same conclusion, 2 Cal. R. C. R., page 989, in which the Commission said:

That it is the duty of a water company to supply service connections up to the property line, and meters, where meters are used, without direct expense to the consumer, seems clear both on principle and on authority. Such requirement seems entirely reasonable. The service pipe up to the property line and the meters, where used, are as necessary in the performance of the water company's duty to the public as its reservoirs, wells or mains. The consumer has no right to dig up the streets to lay a service pipe. That right belongs to the water company alone. It seems unreasonable to ask that the consumer should pay for service pipes and meters which are a part of the water company's system, which the consumer has no legal right to install and which are under the complete control of the water company.

Monthly Service Rates

The service rates suggested, which would be a regular monthly charge, in addition to regular meter rates, were as follows:

⅝ in. meter	40c per month
¾ in. meter	75c per month
1 in. meter	$1.25 per month
1¼ in. meter	1.80 per month
1½ in. meter	2.50 per month
2 in. meter	4.00 per month
2½ in. meter	6.00 per month
3 in. meter	8.00 per month
4 in. meter	12.00 per month

One advantage of a service charge is that it tends to regulate the department's income and thus aid in meeting current expenses, while graduating the charge according to the size of meter and connection protects the department against consumers demanding much larger fixtures than necessary.

Consumption of Water

As close as could be ascertained, the yearly consumption of water would be distributed as follows:

Measured by ⅝ in. meters	1,440,000 cu. ft.
Measured by larger meters	188,520 cu. ft.
Passing meter without registry	50,000 cu. ft.
Street sprinkling	290,000 cu. ft.
Drinking fountains	180,000 cu. ft.
Flushing sewers, etc	30,000 cu. ft.
Flushing trenches	10,000 cu. ft.
Testing meters	600 cu. ft.
Use in extinguishing fires	32,400 cu. ft.
Total	2,221,520 cu. ft.

It is very clear that the first three items should be paid for by the water consumer; the last one charged to fire protection, and the remainder should be charged to the village at large.

Unfortunately no means had been provided at the plant to determine the amount of water pumped. It was therefore assumed that the above would constitute about 60% of the water actually pumped and that 40% would be unaccounted for.

Annual Expense

The total annual expenses for everything connected with the department was about as follows:

Interest on bonds $130,000 @ 6%	$7,800.00
Interest on other indebtedness, $15,000 @ 6%	900.00
Clerk's salary, charge to Water Department	960.00
Superintendent's salary	1,800.00
Labor	600.00
Office supplies, postage, etc	500.00
Fuel	30.00
Meter repairs	100.00
Maintenance, supplies and depreciation	1,500.00
Electric current	612.50
Insurance	30.00
Telephone	25.00
Total	$14,857.50

It will be remembered that the extensions made to the distributing system were made necessary because of private wells becoming exhausted due to mining operations. The total number of houses to be served by these extensions was 331, while the number who declared their intention of taking water was but 155.

It is at once apparent that a rate for water which would yield a fair return on an investment such as incurred by these extensions would be unreasonable, and at the same time it would not be just or fair to place this additional expense on such consumers as the village already had.

The village was under moral obligations at least to contribute something to the relief of parties who had been deprived of well water. They were also engaging in a commercial enterprise, and should expect, the same as in any other business, to do so for a time at a financial loss.

It was therefore estimated a reasonable deficit over a fair return on these extensions would be $1,700 per year, which should be included in the proportion of the expense borne by the village at large.

From the foregoing data the rates which should be put into effect and the income to the water department would be as follows:

Hydrant rental, 79 hydrants @ $75	$5,925
Deficiency on fair return on extension	1,700

Water used by village @ 18c 100 cu. ft.....	1,000
Total due from village.....	$8,625
Service charge:	
400 ⅝ in. meters @ 40c per month.....	$1,920.00
2 1¼ in. meters @ $1.80 per month.....	43.20
1 1½ in meter @ 2.50 per month.....	30.00
1 2½ in meter @ 6.00 per month.....	72.00
1 3 in. meter @ 8.00 per month.....	96.00
Total from service charge.....	$2,161.20
1,628,520 cu. ft. of water @ 25c per 100 cu. ft.	$4,071.30
Making a total inc. from private consumers of	6,232.50
And a total income from all sources of.....	14,857.50

In this way the village would pay 58% of the total annual expenses and the water consumers 42%.

The Wisconsin Commission ruled, in the case of Ashland, Wisconsin, that the city should pay 54.5% of all fixed charges; and in the case of Ripon, Wisconsin, that the city should pay 75% of all fixed charges; in which case it would seem that the distribution at Crosby would not be unreasonable.

Such items as clerk's salary were all charged to domestic service, while the fire service was charged with its share of interest on bonds, maintenance of fire hydrants, etc.

Rates in Effect in Minnesota Cities

The case of Crosby will illustrate fairly well some of the principles of arriving at proper rates in a given case. We will now briefly consider the rates now in effect throughout the state.

The following figures are necessarily not exact, but they are taken from about 140 towns and are therefore reasonably representative.

Fifty-seven percent of the water plants in the state receive nothing whatever from the municipality in the way of hydrant rental or payment for fire protection. Where hydrant rental is paid, it ranges all the way from $4 per year per hydrant to $140, the average being about $35.

Seventy-eight per cent of the towns pay nothing for water used for public purposes, such as street sprinkling, while of those who do pay, 69 per cent do so on a flat rate basis, without regard to the amount of water used.

In commercial service, about 44% are on a strict meter basis, 36% on a combined meter and flat rate basis, and 20% are on a flat rate.

The rates in most cases are on a sliding scale, decreasing as the amount of water used increases. The most extreme case is a town of a little over 3,000, where they have 21 different rates for water and 20 different rates of discount for payment of bills when they become due.

In most cases the revenue derived from commercial service is not sufficient to cover the department's needs, and certificates of indebtedness are issued. These certificates bear 6% interest and in many cases can only be disposed of upon a discount of about 10 per cent.

Paper of this kind is allowed to accumulate until a special levy in taxation is made or bonds issued for paying off the indebtedness.

The whole procedure is an expensive and extravagant way of doing business. In consideration of the present state of the money market, many towns would do well to revise their water rates and place their departments on a cash basis.

Legal Features in Connection with Installation of Service Mains

A full legal discussion relative to who should bear the cost of installing service mains and as to the ownership of such mains when installed would of itself necessitate a very long paper. The following discussion applies particularly to villages and municipally owned plants.

As to whether the consumer or the municipality should bear the cost of installing the service mains, the Minnesota laws very clearly leave this to the discretion of the governing body, who may require the consumer to pay part or all of the expense, or, on the other hand, may install the service entirely free of charge, as they may deem advisable.

Our Attorney General's office has handed down an opinion that it is customary in this state to consider the service pipe from the main to the shut-off box a part of the main.

Section 1313 of the 1913 statutes reads as follows:

"The village council of any village now or hereafter having a water works system shall have power to levy a special tax upon all property especially benefited thereby, in front of which any water main shall be laid."

Section 1314 reads:

"The same may be divided up into five annual installments and shall not exceed the sum of one dollar per lineal foot of pipe laid in front of each lot or parcel of land, against each tract of land, and the same shall be a lien upon such land from the time that the tax is levied by the village council as hereafter provided, provided however, that no lot or parcel of land shall be subject to such tax after five annual assessments have been levied, except as hereinafter provided."

Section 1326, Supplement 1917, a very lengthy section, reads in part as follows:

"It shall be the duty of every owner or occupant of any abutting property platted into lots and blocks having dwelling house or business property situated thereon to install a toilet in said dwelling or business property, and make connection thereof with the water and sewer in the street or alley adjacent thereto." * * *

The section then provides that in case of refusal the village may install such connection and assess the entire cost to the property, and that the payment of such assessment may be made in three annual installments.

It is thus very evident from the statutes themselves that the main and the service pipe are considered as two distinct features of the system, the assessment for the first being limited and spread over a term of five years, while the assessment for the latter is limited only by the cost, and must be paid in three years.

However, the Attorney General's office may not be so far wrong after all, for when we come to the ownership of the service pipe, or vested title therein, it seems a settled question that the village or utility has title to both, notwithstanding the fact that the consumer may have paid in full the cost of installing the service, and is in this way considered an essential part of the main.

Mr. John W. Alvord, in a paper read before the Second Annual Convention of the New Jersey Utilities Association, cites the case of the Knoxville Water Company, wherein in valuing the property for a rate case the com-

pany presented to the court the claim that all services were the property of the company, whether provided at the company's expense or at the expense of the private consumer. On this point the master's opinion was as follows:

"In the matter of services there is much difficulty, not as to price, for the proof seems to be with complainant (water company). Defendant's plumber witnesses when under cross-examination rather confirm it. Defendant says, and proof shows that consumers were made to pay for all but 423 of the 4,323 services stated. * * * Complainant says it actually owned these connections, * * * they are in the streets and cannot be changed by the consumer. In case of competition this consumer would not be permitted to connect this with another main. * * * The contention is that no matter how obtained, the property is theirs and the charge heretofore made was an additional charge for water at that time, etc.

"I see no way of resisting this conclusion, although I confess to much sympathy with defendant's contention that the citizens having paid for it should not be charged an interest on its value.

"The master then allowed the sum of $38,714 for the service pipes.

"The U. S. Supreme Court, in passing upon this case, examined the allowances of the master in detail, making no deductions from the master's findings on the value of services. The Supreme Court refers to the service pipes in the following language:

" 'The first fact essential to the conclusions of the court below is the valuation of the property devoted to the public use, upon which the company is entitled to earn a return. That valuation ($608,000) must now be considered. It was made up by adding to the appraisement, in minute detail, all of the tangible property, the sum of $10,000 for organization, promoting, etc., and $60,000 for going concern value. * * * The cost of reproduction is not always a fair measure of the present value of a plant which has been in use for many years. The items composing the plant depreciate in value from year to year in a varying degree. Some prices of property, like real estate, for instance, depreciate not at all, and sometimes, on the other hand, appreciate in value. But the reservoirs, the mains, the *service pipes,* structures upon real estate, standpipes, pumps, boilers, meters, tools and appliances of every kind begin to depreciate with more or less rapidity from the moment of their first use.'

"It will thus be seen that the master included the service pipes in his valuation on the theory that title was in the company, although paid for by the consumer, without any allowance in the reproduction cost for the contribution, and that the United States Supreme Court, by inference at least, affirmed his report as to the service pipes being the property of the water company."

Mr. Alvord also referred to a case presented to the United States Supreme Court in the Washington Gas case (Washington Gas Company's, District of Columbia, 161 v. s. 316,326). Here the company wish to disclaim all title to the service pipe on the grounds that it had been paid for by the consumer, and thus avoid liability because of a defective service box. Mr. Justice White, speaking for the court, said:

"The plain object contemplated by the formation of the gas company was the supplying of gas to be by it manufactured to consumers, and it is obvious that this could not be done without making a connection between the street mains and abutting dwellings. When such connections are made with the mains they receive from them and convey into dwellings highly inflammable material, which flows by an uninterrupted channel from the mains themselves. It must therefore necessarily have been contemplated that such connections with the mains as were from their very nature incidental to an inseparable connection with the consumption of gas should be a part of the apparatus of the gas company, and be under its control, rather than under that of the city or the property owner.

"Indeed the control by the gas company of the connection from its mains to the point of use is as absolutely necessary to make it possible for the company to carry out the very purpose of its charter as are the retorts and mains.

"Moreover, the provisions of the charter show that it was thereby contemplated that the connection between company's mains and the places where the gas was to be consumed should be made by the gas company, and become a part of its apparatus.

"The charter does not confer the power upon those desiring a supply of gas, but gives such power to the company. * * *

"We conclude, therefore, that the duty was imposed upon the gas company to supervise and keep the gas box in repair. This duty not only did not conflict with the charter of the company, but, on the contrary, is sanctioned by its tenor and is imposed as an inevitable accessory of the powers which the charter confers.

"Nor do we think that this duty was affected by the circumstances that the cost of the labor and materials used in the construction of the connection and gas box was paid by an occupant or owner of property, who desired to be furnished with gas. As the service pipe and stop cock was a part of the apparatus of the company and was used for the purpose of its business, it is entirely immaterial who paid the cost or might in law, on the cessation of the use of the service pipe and gas box by the company, be regarded as the owner of the mere materials.

"Certainly, it would not be claimed that if the box and its connection became so defective or out of repair that gas escaped therefrom and caused injury the company could legally assert that it was under no obligation to take care of the apparatus because of the circumstance that it had been compensated by others for its outlay in the construction of the receptacles from which the gas escaped.

"The argument seeking to distinguish between the service pipe and other appliances of the gas company and the gas box so as to make the company liable for one end and not for the other is without merit. All these appliances were parts of the one structure put in position and used together for the purposes of the company."

The conclusions reached after investigating all available court decisions are that the consumer in paying all the costs incident to installing service mains does not acquire ownership, but is simply making a contribution, paying in advance for anticipated services or paying in part for the enhanced value of his property because of such installation.

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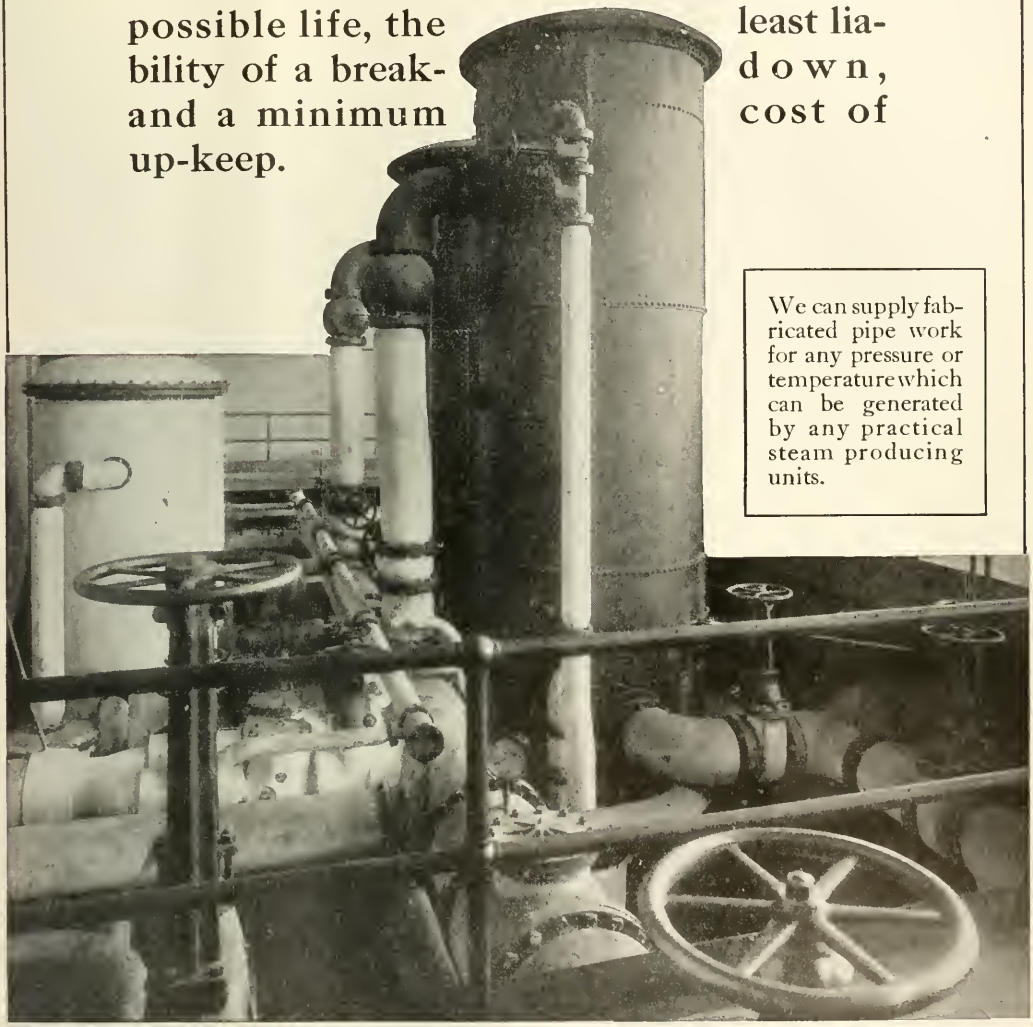

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By assuming the burden of installing service mains the consumer supplies a portion of the necessary capital, and is entitled to consideration to that extent in the rates charged for water service.

The Minnesota laws, in leaving the question as to who shall furnish the capital for installing service mains, the consumer or the village, to the discretion of the governing body, seems entirely proper, for in this way the work can be financed by the party who can do so most advantageously.

APPLICATION OF COPPER SULPHATE TO BASIN WALLS FOR CONTROL OF ALGAE

By George F. Gilkison, Chief Chemist, Water Department, Kansas City, Mo.

The object of this article is not to introduce a new method for the control of algae, but rather to show how the Kansas City, Mo., Water Department has, by changing the application of copper sulphate from the water to the basin walls, been able to control this annoying growth in the clear water basins.

Algae Troubles

Kansas City takes its water supply from the Missouri River at the Quindaro Pumping Station, 10 miles above the city. This station has a basin capacity of 90 millions gallons. The water is purified by sedimentation aided by coagulation and chlorination. It is then delivered to the Turkey Creek Station, which is the distributing station. We have seven storage basins with a total capacity of 38 million gallons, located at different points throughout the city. It is in these basins that the algae growth causes the most annoyance. The basin becomes very unsightly, due to the fact that Spirogyra predominates and appears in long filaments throughout the basin. It also causes trouble in the meters by stopping up the strainers. At times offensive odors are generated due to the development of Anabaena and other Blue Green Algae.

First Control Method Tried

The method first used to control this growth was to scrub the walls with long handled wire brushes. This was not successful due to the fact that the algae was torn lose from the walls and a large amount of it floated in the water and would attach itself to the wall again at the first opportunity.

Second Method Tried

The next method we tried was taking a known amount of copper sulphate in a sack and by means of a rope attached to it, dragging the sack along the wall on which the algae was growing. The disadvantages of this method were that the current caused by the sack would carry the copper sulphate solution away from the wall and the strength of the solution being applied was unknown. This method also required a great deal of time as the sack had to be drawn back and forth over the same wall to kill the algae growth.

Applying Copper Sulphate With Coagulant

To overcome the uncertainty of concentration, an experiment was made at the Quindaro Station in which the copper sulphate was applied with the coagulant to the water. Copper sulphate being incombatable with aluminum sulphate, the two were dissolved in the same solution and applied to the water as it passed over the weir by means of a perforated pipe line. The volume of water passing over the weir was known. We added copper sulphate at this point and in this way were able to calculate the parts per million in the basin. We started with 0.25 parts per million and progressively increased this to 1½ parts per million. There was no apparent action on the wall growth until the concentration of the copper sulphate reached 1 part per million and at that concentration the algae at the end of the basin at which the copper sulphate was being applied was killed, but 1½ parts per million was necessary to clear the far wall. This experiment was followed by an enormous increase in the bacterial count in the basin. The alkalinity of our water at the time of this experiment was 185 parts per million. While chemical analysis was not made on the effluent water from this basin, I feel safe in saying that most of the copper sulphate was lost by reaction with the alkalinity of the water. The following varieties of fish were present in the basin; cat fish, carp, perch, drum, shad, and buffalo, none of which were killed.

Direct Application to Basin Walls

Copper sulphate is now used in a known strength solution, and is applied directly to the algae growth on the basin walls. The water elevation in the basin to be treated is brought down below the algae line (which is about 6 ft. below the normal elevation in our basins). This leaves the algae clinging to the wall. A paint spraying pump is attached to an 8 gal. keg which is mounted on wheels and equipped with a handle. A 5 per cent. aqueous solution of copper sulphate is made by dissolving 6½ lbs. of copper sulphate crystals in 10 gals. of water and poured into the keg, and while one man operates the pump another man directs the flow of the solution which is delivered in a fine spray. After an hour's time the walls are scrubbed with a wire brush and the basin is again filled to normal elevation.

One gallon of this solution will cover 125 sq. ft. of wall surface and can be applied by two men with a spraying machine in four minutes.

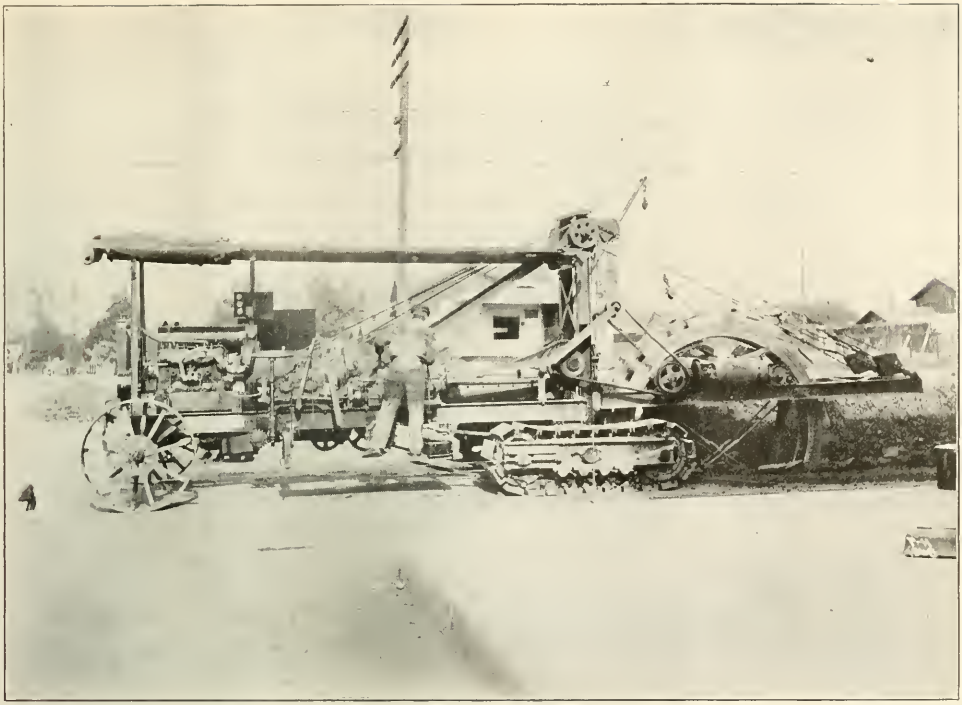
We have found that by carrying out this method every two months during the warm weather we are able to keep our basin walls comparatively free from algae.

This paper by Mr. Gilkison was presented at the 1920 annual convention of the Iowa Section of the American Water Works Association.

SOME ENGINEERING AND ECONOMIC FEATURES OF THE MUNICIPAL ELECTRIC SYSTEM OF LOS ANGELES

By E. F. Scattergood, Chief Electrical Engineer, Department of Public Service, 645 So. Olive St., Los Angeles, Calif.

The development by the City of Los Angeles, of hydroelectric power along its aqueduct and on natural streams tributary to its aqueduct water supply and its distribution within the city, was originally planned that electricity might become a convenience, rather than a luxury, in the domestic and commercial life of the city and that the establishment of industries beneficial alike to the city and the whole southwest might be encouraged by an abundant supply of cheap power in addition to water, harbor



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and transportation facilities. On account of recent developments in the fuel situation and the unprecedented demands for power, it now becomes a matter of duty and necessity that Los Angeles should both enlarge and speed up its power development program that serious shortages of power may be avoided.

The water supply for the Los Angeles Aqueduct is taken from streams in the Owens River watershed on the esatern slopes of the Sierra Nevada Mountains, a distance of 250 miles from the center of the city, and its ultimate capacity is sufficient to sustain a population of between 2,000,000 and 2,500,000 people.

The aqueduct intake in the Owens Valley, is approximately one-half mile higher than the point at which it discharges its water into receiving reservoirs at the northerly limits of the city and there are four stretches, totalling 12 miles in length, along the aqueduct where the grades are in excess of the requirements for gravity flow. The power development plans of the city provide for the construction of power diverting tunnels and waterways at these locations, similar to waterways for power development along natural streams, and thus developing 115,000 horse-power.

The project also contemplates the development of 100,000 horse-power from the natural streams tributary to the aqueduct water supply and the city is at this time seeking additional water power opportunities sufficient in all to meet the probable needs for such reasonable period as ten to twelve years.

Nine miles of the power waterways along the aqueduct, consisting of rock tunnels, and leading to the two principal aqueduct power sites have been constructed, together with power storage and regulating reservoirs above and below, and a partial plant installation of 37,500 horsepower at one of the sites, has been completed and in operation since April, 1917, and of 28,000 horse-power at the second site, since the first week in July of the present year.

Municipal distributing lines in portions of the city are serving 11,000 light and power consumers and, pending the city's proposed purchase of the Southern California Edison Company's distributing system within the city limits the company is operating the same as an agent of the city and the bulk of the necessary power is being supplied by the municipal hydro-electric plants. An issue of $13,500,000 of power bonds was authorized in June, 1919, $11,000,000 for the purchase of the Edison Company system and $2,500,000 for the construction of additional power plants. These bonds have been tied up in litigation ever since by opposing selfish interests, but it is expected the funds may be available within a few months.

During the past two years of low stream flow in California the flow in the city's aqueduct has been increased to an average considerably in excess of that required for domestic and agricultural purposes in order to help out the power supply generally in the southern portions of California and the San Joaquin Valley, the city having maintained a high flow during the greater portion of the winter of 1919-20, in order to minimize the shortage in the San Joaquin Valley, until the rains gave relief. The increased flow in the aqueduct and the completion of the city's second large plant last summer has made possible practically the elimination of all loss from power shortage in the southern end of the state, both inside and outside of Los Angeles.

Rates for electric service in Los Angeles are comparatively low, the reason for which is to be found, primarily, in the advantage which a large municipality has over a private corporation on account of its greater financial credit and the simplicity of its working organization resulting in large savings in interest and in general expense, also resulting in a higher degree of engineering efficiency in municipalities in which the appointment of competent executive engineers is insisted on; plan carefully, build well and thus secure good service without undue maintenance and duplication of investment.

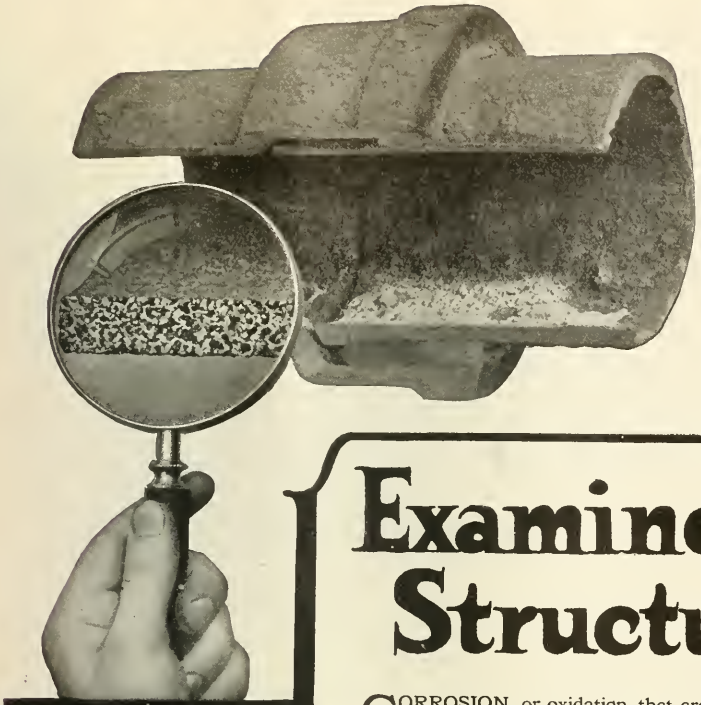
The large increases in rates charged by the companies for electric service in California are, of course, in part the result of the increased cost of labor and material but they are due in large part to the limited credit of private electric utilities, resulting in rates of interest as high as 8 or even 10 per cent. on short term securities. In some instances the companies are asking that rates be fixed on the basis of the earnings necessary to enable them to borrow money for the construction of additional plants rather than on the basis of existing capital investment, and the State Railroad Commission, in exercising control over the companies' rates must choose between a continued power shortage and the establishment of such rates as may result in the construction of additional plants.

Ordinarily small communities cannot develop hydro-electric power to advantage except by the formation of utility districts and it is manifest that the investigation by the state of water conditions and the possible formation of water districts in California, which is very properly being urged, should include water power as well. It is not apparent why the state itself as a matter of duty, should not at this time develop a large amount of the hydro-electric power now lying idle in the Sierra Nevada Mountains. This could be done without injury to any existing investment but on the contrary should result in a measure of relief and, I believe, would be so regarded by most companies, as the power could be distributed through existing agencies without creating any considerable disturbance or economic waste.

It makes but little difference who develops the power if it is developed in sufficient quantities and cheaply, as water power will never be hoarded while the supply for other communities is exhausted. Large municipalities can develop hydro-electric power to advantage and should do so in order to reduce the amount of money which the private corporations must borrow and the tendency toward increased rates.

The City of Los Angeles, following particularly the lead of its Chamber of Commerce, in the establishment of a municipal harbor and an ample water and power supply is not acting entirely through selfish motives by any means, but recognizes the fact that the welfare of the southwestern communities generally is linked with its own and that their interests are interdependent in large degree.

The City's Power Bureau is not of choice indulging in any propaganda of an argumentative sort on the question of municipal versus private ownership, but some people favoring private ownership of public utilities and, therefore, much disturbed by the disparity between the



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electric rates within and without the City of Los Angeles, insist on accusing the Los Angeles Bureau of Power and Light of being unfair and lacking in frankness and truthfulness while they alone are indulging in such practice and they alone appear concerned about the relative showing of municipal vs. private ownership. For your information in this connection, I wish to add the following:

(a) The claim often made that the city's power project profits unduly from its aqueduct investment is erroneous in that the power funds have been used for construction of waterways and reservoirs and the power plans contemplate the further construction of waterways and reservoirs fully equal to the corresponding features for the important power developments of the companies on natural streams along which they have selected and developed only the more advantageous sites.

(b) The accounts of revenue and expenditures of the Power Bureau are kept in strict conformity with the system of accounting established by our State Railroad Commission.

(c) The municipal rates for electric service in Los Angeles prior to October 11th, of this year, provided a base rate of 5 cts. per K. W. Hour for electric lighting, scaling down to 1.8 cts. per K. W. H. for all energy in any one month in excess of 3,000 K. W. H., and provided a base rate for electric power of 4 cts. per K. W. H. scaling down to 0.76 cts. for a consumer using 1,500,000 K. W. H. or more per month, with discounts up to 16 per cent. for the higher load factors. Assuming the city in possession of and operating the Edison distributing system in the city combined with its own during the calendar year 1921, the earnings, with those rates charged to all consumers, would be sufficient to give a surplus of $400,000 in excess of operating expenses and proper allowances for fixed charges on the total capital investment, including the $11,000,000 proposed to be paid to the Edison Company. The city is receiving as good return from its industrial power as from any other service and is not "subsidising" power consumers.

(d) The city built its second large hydro-electric plant, completed last July, believing that revenues from the power bonds authorized in June, 1919, would be available by the time the plant was completed, but the prolonged litigation made necessary an increase, temporarily, of 12½ per cent in the municipal rates in order to enable the Power Bureau to meet its obligations, having no other source than revenue from which to pay for the plant. For the same reason the Board of Public Service Commissioners, having charge of the water and power projects of the city, has been compelled, temporarily, to abandon its policy of providing for interest and sinking fund requirements on power bonds out of the power revenues and the taxpayers of Los Angeles have helped build a plant which has benefited other communities as much as the city in preventing power shortage.

It is unthinkable that our statutes continue to permit selfish interests, in a wholly irresponsible manner, to tie up issues of bonds, approved by two-thirds of the people for the establishment of municipal utilities, as has been done three times in succession with the Los Angeles power bonds. Such interests should be made responsible for the resulting damage, in event of failure of their suits, or other provisions should be made to prevent acts so detrimental to the public interest. This may become a question of great importance to all communities in connection with state, municipal or district utility matters and merits careful consideration.

This paper by Mr. Scattergood was presented at Chico, Calif,, recently, before the League of California Municipalities.

ANNUAL MEETING MINNESOTA SECTION AMERICAN WATER WORKS ASSOCIATION

The Duluth meeting of the Minnesota Section of the American Water Works Association was one of the best the section has yet held from the standpoints of attendance and interest shown in the discussion of the papers presented. The following notes on the meeting were contributed to Municipal and County Engineering by a valued Minnesota reader:

Mr. C. J. Sullivan suggested in his paper that the water purification plant operators in Minnesota should be registered or licensed, so as to insure competent operation of the plants. This idea was favorably received by those present.

Mr. E. W. Kelly described the Duluth water works and the problems encountered in providing water for a city that has such a variation in elevations as has Duluth. The city is divided into four zones, each of which is served by its own reservoir and pumping station.

The Commercial Club provided a most enjoyable luncheon for the visiting members, after which there was an automobile drive to the Aerial bridge, the main pumping station, and along the beautiful boulevard system that extends along the bluffs.

Mr. John Wilson described the methods used in arriving at an equitable rate for water supplied to small cities and villages. Mr. Wilson presented a paper that was up to his usual high standard. A resolution was passed asking Mr. Wilson to extend the data presented. The complete paper is published in this issue of Municipal and County Engineering.

Mr. William C. Lounsbury gave a most interesting description of difficulties encountered in providing a pure water supply for the City of Superior, Wisconsin. The water is obtained from wells located on Minnesota Point and is then pumped across the bay to the Wisconsin side. He illustrated his talk with lantern slides.

"The Thawing of Frozen Water Pipes" brought out considerable discussion, as it appeared to be a subject in which all water works plants in Minnesota are interested.

"Keeping Chlorine Machines in Operation" was omitted from the program because of the lateness of the hour. It will be presented at the next meeting.

"The Use of Chlorine for the Sterilization of Water Supplies and Its Effect Upon Their Potability" was the last subject discussed. A brief resume was given by Lewis I. Birdsall of the history of water sterilization with hypochlorite of lime, the advent of the liquid chlorine machine, the use of chlorine for water sterilization during the war, and its almost universal acceptance at the present time as a means of water purification. Stress was laid on the necessity of competent supervision and careful laboratory control of chlorine plants, and it was also pointed out that duplicate installations and extra repair parts are highly essential.

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A resolution was passed urging the State Legislature and the Governor of Minnesota to grant an increased appropriation for the Sanitary Division of the Minnesota State Board of Health in order that it may extend its splendid work of supervision of the water supplies of Minnesota.

THE RELATION OF HOUSING TO ENGINEERING

(Continued from page 210)

Development of Town Plan

Where a number of houses are to be constructed in a group, their arrangement with respect to one another, and the provision of the necessary traffic routes and open spaces give additional opportunity for the co-operation of the engineer. The services of the realtor will be of importance in connection with subdivision for sale or renting; and the advice of landscape architects will be required in providing park areas, planting, the grouping of buildings in civic centers and other accessories which are needed to make the development attractive. However, it is the engineer who must make the necessary topographic and land surveys; who must work out the basis of districting and zoning for restricting the use of property into lots and blocks; and who must locate, in accordance with the requirements of traffic, main thoroughfares, secondary streets and other features of the town plan.

Streets and Pavements

Houses are only one part of a housing development, which could not be used without the passageways by which their occupants pass to and from them, and to and from their working places. The designing of these ways is strictly an engineering problem, including the determination of widths, grades and cross-sections; the provision of drainage; the selection of materials; and the designing of sidewalks, curbs and gutters and other accessories. The close relation of clean, paved streets to public health commends this phase of the relation of engineering to housing to the special consideration of the sanitary engineer.

Water Supply

The water supply of the housing group is, of course, the special field of the sanitary engineer. The determination of the quantity of water required, the selection of a source of supply and the design of suitable purification, pumping and distribution works all are within his field.

Sewerage and Drainage

Of no less importance than the supply of water to houses is the provision of facilities for removing waste water, both that which results from the use of the water supply, and that which falls as rain. The design of sanitary and storm sewers and of sewage treatment and disposal works are again the special field of the sanitary engineer.

Refuse Disposal

The removal of solid refuse, including garbage, rubbish, ashes and street sweepings, and their final disposal by burying, feeding, reduction or incineration are all part of the service for the furnishing of which the sanitary engineer must be called upon in connection with the solution of the housing problem.

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While not of especial sanitary significance, these public utilities, which are so important for the convenience of modern city residents, constitute a still further field for the activities of the engineer in connection with housing.

Houses and Plumbing

The design of the house is the special field of the architect. However, the health of the occupants depends upon the provision of sufficient air space and of suitable means for entrance of light and air. The sanitary engineer has therefore been able to perform useful service in connection with the development of satisfactory standards with respect to these features. An additional feature of house construction which is of great sanitary importance is the house plumbing. The value of the all-important sanitary services of water supply, sewerage and drainage would be lost without the pipes, fixtures and other apparatus required for distributing water within the house and for accordance with scientific principles and natural laws as it is that the water pipes and sewers in the ground shall be designed in accordance with good sanitary engineering practice. Great economies in house construction are also removing liquid and water-carried waste. It is just as important that these pipes and appliances be installed in possible where the architect takes advantage of the sanitary engineer's most modern practices.

Construction

The organization, direction and supervision of construction on housing projects are wholly within the field of the engineer. The sanitary engineer also has especial interest in the sanitation of construction camps and the provision of temporary water supply and other temporary sanitary facilities.

Management

Where large groups of buildings are constructed and maintained as separate communities, skilled managers are required to handle the maintenance, rental and sale of houses, the operation and maintenance of water supply and sewerage, the supervision of garbage and waste removal, the upkeep of roads and pavements, the care of public grounds and parks and the administration of public health and police affairs. Executive ability and human qualities are of more importance in determining the success of a town manager than are professional training or experience; but where a large development has been constructed, it would appear that, provided he has the other necessary qualifications, one of the engineers who has taken an active part in the construction would probably be as suitable as anyone for the position of manager.

Regulation

Although, under present conditions, the elimination and prevention of undesirable housing conditions by public regulation has become a less prominent feature of housing work than the construction, which is so urgently needed, such control nevertheless remains an essential part of the housing program and continues to require the best efforts of some of our most capable sanitary engineers. The very shortage of houses has itself caused an increase of congestion in our cities which calls for more than usual sympathy and intelligence in the administration of housing regulations, and even houses which are now constructed in accordance with the best sanitary practice must be properly managed and maintained under public supervision if they are not to degenerate into slums. The importance of reducing construction cost also calls for a reconsideration of building and housing codes, with a view to attaining economy without sacrificing any essential sanitary aims. A wide field of usefulness for the sanitary engineer is therefore open in this direction.

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CONSTRUCTION NEWS AND EQUIPMENT

COUNTY ROAD COMMISSIONERS SUCCESSFULLY EMPLOY POWER DRAG SCRAPER IN WORKING GRAVEL BANK

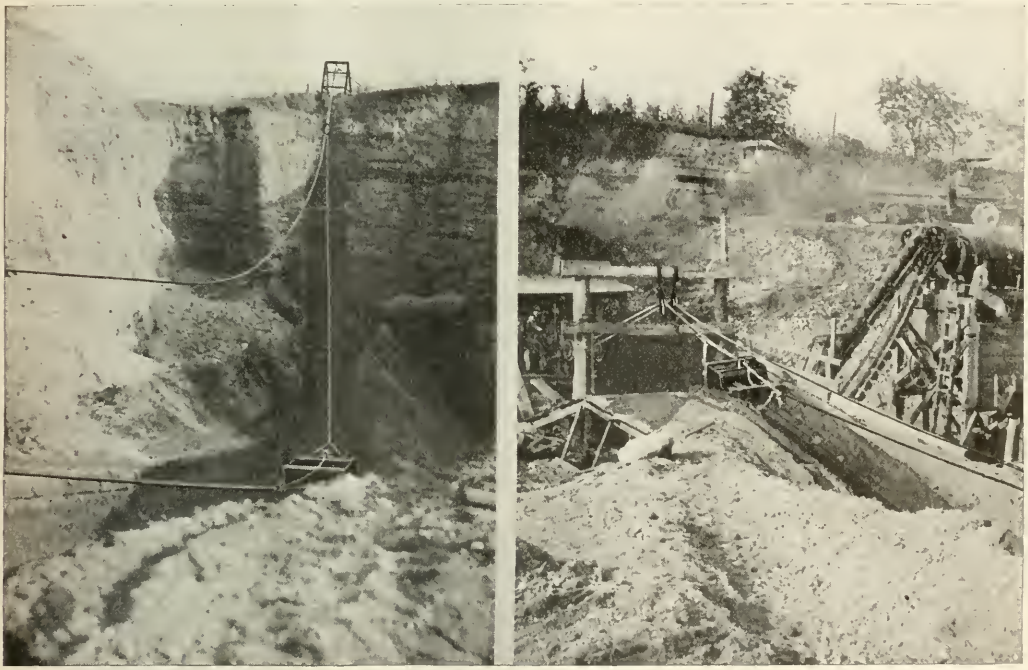
The results obtained by the Cass County, Michigan, Road Commission this season by discarding teams and slip scrapers in favor of a mechanically operated drag scraper should be of interest to all road commissioners and contractors who are working small gravel banks.

The Cass County gravel deposit is a ridge about one-half mile long, running back from the main highway midway between Cassopolis and Dowagiac. As the result of several seasons' operations with teams and slip scoops the end of the ridge near the road was gradually cut down and a pit about 50 ft. in diameter had been created when the commission decided last July to increase the output of their pit and at the same time reduce the cost of excavating and handling the gravel by installing a power scraper.

The equipment previously used—a "Good Roads" portable screening plant, loading hopper, small jaw crusher and traction engine to drive the crusher, elevator and screen—was moved into the center of the pit and the new equipment, consisting of a 1/3 cu. yd. Sauerman Bottomless Power Scraper operated by a Clyde 6¼x8 double-drum, double-cylinder steam hoisting engine, was set up in a position to enable the scraper to excavate for a distance of several hundred feet into the ridge and convey the excavated material to the loading hopper at the screening plant.

At the end of its first two months of operation the power scraper had opened a new cut about 20 ft. wide and 30 ft. deep for a distance of about 100 ft. into the ridge. According to Mr. D. P. Smith, county road superintendent, who laid out and directed the installation of the equipment, the power scraper is accomplishing the work that would require a half dozen team scrapers and the cost of operating the power scraper is much less than the expense of handling the same work with teams.

The entire operating expense of the scraper is $14 per day, including coal, light repairs and the wages of the hoist engineer, who also acts as fireman. The daily cost of getting out a smaller amount of material with



VIEWS ILLUSTRATING THE USE OF A POWER DRAG SCRAPER BY THE CASS COUNTY, MICHIGAN, ROAD COMMISSIONERS IN WORKING A GRAVEL BANK.

Printed as Insert to MUNICAPAL AND COUNTY ENGINEERING, Chicago, Ill., December, 1920.

teams and scrapers before the power equipment was installed was $40 per day. The daily yardage handled by the power scraper has averaged 125 cu. yds., which is all the screening plant can take care of in 10 hours. The scraper cannot be operated continuously on account of the limited screening capacity, and could excavate and convey 250 cu. yds. per day under ideal conditions, according to Mr. Smith.

The accompanying illustrations give a good idea of the Cass County operations, and one photograph in particular shows the difficult nature of the digging, which is mostly in gravel so firmly packed that it will not yield to an ordinary plow pulled by a team of horses.

THE DEVELOPMENT OF STEEL FORMS AS USED IN ROAD CONSTRUCTION

By W. J. Savage, Manager of Sales, The Heltzel Steel Form & Iron Co., Warren, Ohio

When steel forms for road building and similar uses were originated and introduced to contractors to displace the wood forms then in use, the first objection to them mentioned was their weight, the word "steel" causing, in golf terms, a "mental hazard" which was not overcome without considerable effort. This erroneous impression prevailed for a time, but soon foresighted contractors realized the saving due to steel forms in setting,

FIG. 1.—ILLUSTRATES METHOD OF SUPPORTING BACK RAIL, ALSO USED IN SUPPORTING ROAD RAIL UP TO 1916.

and recognized the elimination of all other disagreeable features such as warping, buckling, loss of mixture, etc.

The first practical steel form for use in building roads and the like was brought out in 1909 by Mr. J. N. Heltzel, now president of the Heltzel Steel Form & Iron Co., Warren, Ohio. This form was made of No. 14 gauge open hearth steel, given double depending flanges both top and bottom of the rail, and supported by a steel angle stake with a clip riveted flush to top, upon which to hang the rail. Hence the term "Heltzel Hanging System." To form a continuous rail, sleeves were fastened to each rail, and the succeeding form, joined upon this sleeve.

This form proved an instantaneous success. Perfect workmanship was secured, and the strong yet light steel form, permitted a smooth operation of the strikeoff, preventing a wave finish to the road, a defect which was difficult to eliminate where wood forms were used. It was noted the forms stood up well under the rough handling, yet it was decided to increase the gauge material to eliminate any possibility of the form bending or buckling.

FIG. 2—PEDESTAL SUPPORT INTRODUCED IN 1916. Heltzel Hanging System Still Adhered to; Also Shows Joints Formed by Rails Butting Together on Pedestal. Finishing Machines Used on This Rail With Satisfaction.

The following season, an increase to 13 gauge was decided upon, and as years went by, the gauge material used was increased to No. 12, naturally giving greater strength to the form. However, the same double depending flanges on the forms were retained, eliminating bending of the form. Close observation was continued for improvement and in 1917, when heavier strikeoffs and templates were used, it was decided to change from the stake support to a pedestal. It was on this type form that the first test of a Finishing Machine, for building Monolithic Brick roads, was made and although the machine vibrated somewhat, the forms held up admirably.

Up to this date the forms were manufactured in 12-ft. sections, and in heights ranging from 5 to 9 ins., but it

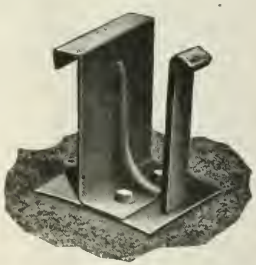


FIG. 3—STRAIGHT PEDESTAL. Same as Shown in Fig. 2, to Support Light Rails With Narrow 2-in. Flange Top and Bottom.

was decided to reduce the length to 10 ft., permitting a closer setup of the pedestals, and securing more rigidity. This same type of forms was also used with complete success under other finishing machines in the construction of concrete roads.

Upon close observation of the action of these finishing machines on steel forms, further improvements were deemed necessary resulting in the production of heavy duty forms.

Heltzel Heavy Duty Road Forms

The bottom flange of the rails was increased from 2 ins. to 4 ins. and the material used was increased from

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12 to 10 and later to 9 gauge. This latter gauge, at the present time, under all tests and conditions has proven sufficient to withstand the weight, vibration and action of all mechanical finishing machines, and the forms are so guaranteed by the company.

The Pedestal

The base plate of the pedestal was increased in size, heavy 3/16 plate now being used, and to give the improved forms a proper support, the design of the pedestal was changed as shown in one of the accompanying illustrations, permitting the rail to rest on the base plate, and preventing it from leaning or buckling under the vibration and strain of the machine, and to prevent sinking when the sub-grade is soft. As it is now manufactured, the rail will withstand a live load of three tons.

The upright is made of heavy pressed steel, 5½ ins. wide, reinforced with a pressed rib in the center and further strengthened with an extra depending flange to

FIG. 4—ILLUSTRATING HELTZEL LIGHT RAILS WITH STRAIGHT PEDESTAL SUPPORT.
Same as Shown in Figs. 2 and 3.

support the road rail. It is riveted to the base plate, which is punched with a slot, through which a flat stake is driven to hold the pedestal in place and prevent creeping of the forms.

In addition to the bearing surface obtained from the increased width of the bottom flange of the rail, are the 70 sq. ins. of the base plate on the pedestal. Naturally, this bearing surface prevents the forms from sinking in a soft sub-grade. A total bearing surface of 522 sq. ins. is thus obtained.

Another strong feature of Heltzel Steel Forms, and one noticed upon the most casual observation, is the total absence of any cuffs, rivets, or supports. There are no couplings of any kind and this eliminates what is known as right hand or left hand rails. Perfectly plain—severely so—all forms may be rapidly set and no time lost in determining upon which side of the road the rail is required. On tests it has been proved a saving of $3 may be made on every thousand feet of forms set, as compared with wood forms or others now on the market. The most unskilled laborer can set Heltzel Forms due to this simplicity.

Further, due to the absence of these parts, should occasion demand the ingress of a truck or wagon to unload materials, the mere exertion of bending over to lift the forms off the pedestals is all that is required. The pedestal may be left in place, as the trucks will clear them.

Of course the same advantageous features apply to the Heltzel Standard Rail, made of 10 gauge material, and used where finishing is accomplished by hand. However, but one pedestal is included with each 10-ft. section.

Despite the improvements in the forms, it is interesting to note that contractors in one or two states still desire the forms first mentioned, namely with the angle stake support. Some of these contractors are still using forms purchased five years ago. Others demand the form with the straight pedestal support, and for that reason the company continues the manufacture of all three types.

FIG. 5—ILLUSRATES OFFSET PEDESTAL FOR SUPPORTING TYPE H AND TYPE L HELTZEL FORMS, INTRODUCED IN 1920.

The Heltzel Steel Form & Iron Co. also manufacture steel forms for all kinds of concrete work, sidewalks, curbs, curb and gutter, battered curb, integral curb and base, etc. The demand is increasing every year and this firm recently completed an addition to its plant, fully equipped with modern machinery, necessary for perfect workmanship.

Heltzel Forms Used on All World Record Jobs

For the past few weeks, much has been published regarding world records in pouring concrete. The contracting world was startled when articles appeared concerning the Alan J. Parrish record in pouring.744 ft. of 16-ft. road, 8 ins. thick in 9½ hours on June 30, 1920. Later, in fact, on August 6, Mr. Parrish poured 779 ft.

The ink was scarcely dry on this report when Garvey Weyenberg Construction Co., Appleton, Wis., bettered this record by several feet.

Next reports were received from Siems, Helmers & Schaffner of St. Paul, Minn., who poured 1,072.6 ft. of

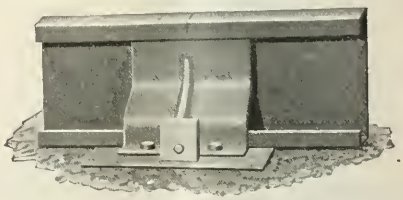

FIG. 6—ILLUSTRATING OFFSET PEDESTAL AND PERFECT JOINTS FORMED BY RAILS BUTTING TOGETHER ON PEDESTAL.

18 ft. road in Rice County, Minn. Later this record was bettered, these contractors pouring 1.074 ft. in 10 hours mixer running time.

But even this concern's record went by the board, when McCree, Moos & Co., St. Paul, Minn., reported a run of 1,094 ft. of 18 ft. road 7 ins. thick in 8 hours; and last reports advise their expectations of raising this record to over 1,200 ft. of finished pavement in 8 hours.

Going back to the year of 1919, we recall that Thomas

E. Currie of Detroit, Mich., put in 10 miles of 24-ft. road in one season—and this was considered a remarkable record.

While different manufacturers' equipment has been mentioned as being used, and while they were factors in making these records, it is worthy of note that Heltzel Steel Road Forms were used on *all* these record jobs.

The Heltzel Forms used by Alan J. Parrish were 8-in. Heavy Duty Road Forms, two pedestals being used to a rail. Those used by McCree, Moos & Company were Heltzel Light Forms with the 2-in. narrow flange, and Type L forms with two pedestals per 10-ft. section. Garvey Weyenberg Construction Co. used the Heltzel Light Rail 7 ins. deep by 12 ft. long with a 2-in. flange both top and bottom. Thomas E. Currie used 6-in. Light Forms, same dimensions as given on Garvey Weyenberg Construction Co. forms. Siens, Helmers & Schaffner used the Heltzel light form with the narrow 2 in. flange top and bottom.

Further, on all these record jobs, and naturally on all type forms mentioned, with the exception of the Thos. E. Currie job, several mechanical road finishing machines were used. This fact is worthy of special note, as steel forms must be strong enough to withstand the weight and vibration of these machines. (Note that three differ-

(Continued on Page 32)

A Labor-Saver for Small Gravel Pits

One Man with a Sauerman Bottomless Power Scraper Does the Work of a Large Gang of Men Using Team Scrapers.

CONSERVATIVE claims for the smallest sizes of Sauerman Bottomless Power Scrapers, based on the statements of contractors and county road commissioners who are using them, are that a Sauerman scraper operated by one man will displace from 6 to 15 teams and slip scrapers at a daily saving of $30 to $75. The larger sizes of Sauerman scrapers scrapers are considered by the commercial gravel producers who use them as being the equal of a small steam shovel with the added advantage that they not only dig, but also convey the sand and gravel to the plant.

A Wisconsin sand and gravel producer chose a Sauerman scraper in preference to any other type of equipment when he opened his first gravel pit about six years ago. Today he owns and operates four gravel plants and the excavating and conveying equipment is the same at all—Sauerman Bottomless Power Scrapers.

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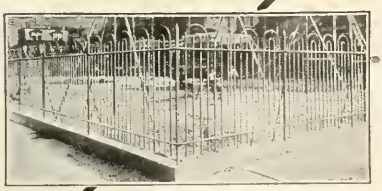

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Effective November 15th, 1920, Prices on War Department Canned Meats are as Follows:

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No. 2 cans	27c per can
1 lb. cans	18c can
6 lb. cans	$1.00 per can

CORNED BEEF HASH:

1 lb. cans	15c per can
2 lb. cans	30c per can

ROAST BEEF:

No. 1 cans	9c per can
No. 2 cans	18c per can
1 lb. cans	12c per can
2 lb. cans	24c per can
6 lb. cans	70c per can

BACON:

12 lb. cans	$2.50 per can

SAUSAGE:

Pork, No. 2 cans	25c per can
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$1,001.00 to $2,500	5%
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CUMULATIVE PURCHASES COUNT

To stimulate purchases of carload lots and to promote sales in large quantities, further discounts as follows are authorized to customers ordering or re-ordering in carload lots, the value of all purchases of canned meats made on or after November 15th, 1920, only, to be considered in connection with the scale of discounts, as follows:

When purchases reach $50,001	**24% net to prevail**
When purchases reach $100,001	**28% net to prevail**
When purchases reach $500,001	**32% net to prevail**
When purchases reach $1,000,001 and over	**35% net to prevail**

The foregoing means that the total purchase by a customer in carload lots from time to time will be taken into consideration and the proper discount applied on the sum of all the purchases, including the first carload lot.

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War Department Canned Meats

Buy $250.00 worth or a carload or a trainload—the more you buy the cheaper it is, and remember it is the total of all your purchases that counts in figuring up your discounts. Order—Sell—and Re-order. Then do it all over again.

ORDER—SELL—AND RE-ORDER.

CREDIT SALES:

Depot Quartermasters are authorized to sell surplus canned meats for cash, bankers' acceptance, or on not to exceed ninety (90) days straight credit in the commercial sense.

Credit will be extended only to those individuals, firms or charitable organizations which can establish a satisfactory credit rating (Dun's, Bradstreet's or Banks), or to Municipalities having a bona fide purchasing organization. The credit risk in each case is left to the decision of the Depot Quartermaster.

FREIGHT PREPAID

Shipments of not less than carload lots will be made at government expense to any point in the United States outside a radius of 20 miles of the point of storage from which shipment is made.

The government will not be liable for any demurrage or switching charges that may accrue after goods are loaded for shipment. Prices quoted are in all cases f. o. b. storage point, with freight prepaid, as above specified on carload lots.

SAMPLES ON REQUEST:

Depot Quartermaster in your district will, on receipt of price of samples wanted and postage costs, be glad to send same to prospective purchasers in their respective zones.

GUARANTEED CONDITION

The government guarantees to deliver all meats in perfect condition. The most rigid inspection will be made of each shipment before it leaves point of storage, thus insuring full protection to all purchasers.

ORDER NOW

We respectfully suggest that immediate steps be taken by interested parties to familiarize themselves not only with the superior quality of these canned meats, but that they compare the prices herein quoted with prices for the same commodities from other sources so that they may fully realize the immensity of value to be obtained by participating in the distribution of these goods.

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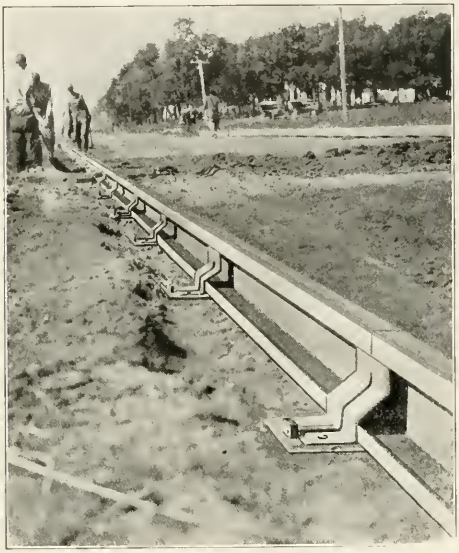
OFFICE OF THE QUARTERMASTER GENERAL

Munitions Building. **Washington, D. C.**

(Continued from page 29.)

ent type Heltzel forms were used under these machines).

The accompanying views illustrate the forms as used by various contractors, and show the improvements made by the Heltzel Company. As a matter of fact, very few changes have been made in Heltzel forms. This company was the first to realize the importance of having a broad bearing surface on the lower flange of the forms, bringing out the Heavy Duty Form the first of 1920.



ILLUSTRATING PERFECT ALIGNMENT SECURED WITH HELTZEL STEEL ROAD FORMS.

This form met with instantaneous approval of contractors, as is evidenced by repeat orders from all sections of the United States. The extreme simplicity of the forms permits rapid set-up, a feature which appeals to contractors. The forms are quickly lined up and set—and stripping from the finished work is child's play.

THE NEW MERRIMAN ASPHALT PLANT SHOWS MANY IMPROVEMENTS

The East Iron & Machine Company, Lima, Ohio, who have been building the Merriman One-Car Steam-Melting Asphalt Plants since 1905, announce that the Improved Merriman No. 3 is now on the market, and several have already been sold. This plant possesses many features which add efficiency and make it easier to transport and handle.

The new plant is only 58 ft. over all and is the shortest complete railroad plant of its capacity on the market. With all this, the guaranteed capacity is 2,000 sq. yds. of 2-in. topping, or 2,800 yds. of asphaltic concrete in a 10-hour day. Users of this plant are now laying over 3,000 yds. of 2-in. topping in a 10-hour day.

The side sills are extra heavy girder construction. They are so constructed that they cannot sag or warp out of shape. The trucks are extra heavy, M. C. B. standard, with 6x11-in. journals, special hammered steel axles and chilled wheels. The arch bars are made of bar steel. The boiler is of the locomotive type, specially built, and of 125 h.p., with a capacity of 160 lbs. pressure. It is constructed under the State of Ohio and A. S. M. E. Specifications, and will pass the Inspection Bureau of every state. It is extra heavy and specially designed, so that it is a good steamer and very easy to clean. The power equipment is specially designed. The engines are of simplified construction, very heavy, and all parts are readily accessible.

Four melting kettles are used, and to insure compactness and solidity they are constructed in one unit. Each kettle is equipped with two steam coils, made of heavy electrically welded pipe. These kettles are so arranged that air pressure can be used to facilitate discharge ot the asphalt, and so that either air or steam can be used for agitation. Clean-out doors are placed at close intervals.

The sand drum is of a special type of construction, and is patented. It is 5 ft. in diameter and 25 ft. long. No internal spiders are used, and four heavy I-beams act as spill plates and carry the sand so that it falls through the heat as the drum revolves. Spiral flights carry the material forward. The drive end of the drum runs on special trunnions and a special riding ring, and is driven by means of gear segments around the outside of the drum. The capacity is greater than the material required for the rest of the units of the plant, and is approximately 25 tons per hour.

The mixer has a capacity of 12 cu. ft. and is equipped with special patented blades, having renewable ends. This mixer is so arranged that the material can be dumped directly into motor trucks which run under the mixer platform.

The hot material storage bin is telescopic and holds 12 cu. yds., or 15 tons, so even with this extra large capacity the bin can be easily closed down on platform without removing any parts.

The working platform, on which the mixer, etc., is located, is a patented arrangement. When extended for operation it permits trucks and wagons to pass under the mixer dump. When packing the plant for shipment it is easily drawn within shipping length of the car, and clears the end of the car frame.

Elevators on both sides of the plant feed the sand drum, so material can be stored on either or both sides. The hot material elevator is entirely enclosed in dust-tight sheet-steel housing, made in sections, which can easily be removed to facilitate packing for shipment.

The fire box is arranged for burning coal, coke, wood or fuel oil. It gives a choice of fuel at all times and saves a lot of trouble. Many other improvements that greatly increase the efficiency of the plant have been made, and the Improved Merriman is attracting considerable attention from the larger contractors.

WORKING ON THE SUB-GRADE PROBLEM

Why highways fail was taken up by engineers, highway officials and scientific men in leading universities at a meeting of the sub-grade committee of the Federal Highway Council, held at Wilmington, Del., Nov. 22

and 23, 1920, under the chairmanship of Gen. T. Coleman DuPont of New York.

Among the scientific men attending were Prof. Hector J. Hughes, Dean Harvard Engineering School; A. T. Goldbeck, testing engineer, U. S. Bureau of Public Roads; Prof. F. H. Eno, chair of engineering, Ohio State University; H. E. Hilts, of the Pennsylvania State Highway Department; H. G. Shirley, of the Federal Highway Council, and Ira B. Mullis, Bureau of Public Roads, Washington, D. C.

Reports were made by problem committees working under a main committee. During the discussion which followed the presentation of these reports the statement was made by W. P. Blair of Cleveland, Ohio, that 20,000,000 people had been added to the population of the United States, practically without one inch being added to the transportation facilities of the country, and that on top of this increased population was an increased tonnage, due to greater buying by the people, equal to another 20,000,000, making a total of practically 40,000,000, in the face of inadequate transportation. The result of this increased tonnage, it was asserted, had been to break down roads, through no fault of construction, but because traffic growth had not been taken into full account.

The development of railway engineering was used as an example to show why heavier type highways must be built since the same law of tonnage growth applies to both the railway and the highway. In the case of railway, Mr. Blair asserted, the laying of heavier rails, enlarging tunnels and reducing grades, has been going on constantly during the past 30 or 40 years, and yet the highway, without a comparative development, had been called upon within the last ten years to sustain a traffic growth unequalled in any like period in the history of the country. The situation this created, it was pointed out, called for a determined effort to build better road foundation in order that breaks in the surface may be eliminated.

Gen. DuPont followed Mr. Blair with the statement that the problem of the subgrade, or road foundation, was the most important duty before highway engineers and officials today. It was his belief, as a result of experience in highway development, that the foundation problem must be solved, and solved speedily, otherwise the movement to round out a complete system of county, state and interstate highway transportation will be retarded, to the great detriment of the American public.

C. M. Upham, State Highway Engineer of Delaware, explained how his department was making field tests to determine the bearing power of various kinds of soil and what methods to pursue in order to increase that sustaining power and thus prevent the breaking down of the road surface.

On the point of road failures, Mr. Shirley, former state highway engineer of Maryland, called attention to the fact that roads are sometimes charged with having failed, despite the fact that in actual service they may have saved their cost many times over before reaching the point where reconstruction becomes necessary.. He hoped, he said, that the public would take this fact into account in their future discussions relating to road building.

S. M. Williams, chairman of the Federal Highway Council, addressed the committee briefly upon the importance of conducting the subgrade research work as rapidly as possible in order that road building upon a greater scale than ever before may go forward without wasteful expenditure of funds upon roads that soon prove unequal to the burden thrust upon them, through a lack of proper understanding of the soil upon which the subgrade rests.

Investigations in widely separated sections of the United States are to be conducted simultaneously and reports made at subsequent meetings of the subgrade committee. The work is under the direction of the Federal Highway Council, which hopes through the movement now undertaken to save millions of dollars to the public in the future in the construction of roads that will not fail.

CONTRACTS AWARDED

ROADS AND STREETS

Ala., Montgomery — L. C. Rawlinson, Montgomery, awarded contract for grading, draining and surfacing 5.44 miles State Trunk Rd., from Girard to Tuskegee, Russell Co., sand-clay, at $38,936; 12.053 miles Chisholm Rd., Florence to Tennessee state line, Lauderdale Co., chert and gravel, to W. T. Taylor Constr. Co., Wilsonville, at $156,885.

Ariz., Tombstone—Dan LaRoe, Palestine, awarded contract for construction of Sec. 2, Douglas-Rodeo Hwy., about 23 miles, to be surfaced with gravel or caliche base, to be 22 ft. wide and top 16 ft., etc., at $130,467.

Ark., Little Rock—Contracts for surfacing Spring Lake Hwy., to cost $983,339, awarded as follows: M. D. L. Cook, surfacing from city limits to Granite Mountain, 5 miles; Oliver Constr. Co., work from Granite Mountain to county line, 20 miles. Approx. $174,279 and $908,060, respectively. The 5-mile section is to be constructed of Warrenite on stone bases and the 20-mile stretch of asphalt concrete on concrete base.

Cal., Bakersfield—Rogers Bros. Co., 350 Merrick street, Los Angeles, awarded contract for reconstructing and widening 13.745 miles Bakersfield-Taft Hwy., at $359,000.

Cal., Los Angeles—Fred Hoffman, 111 E. Twelfth street, Long Beach, awarded contract for paving Hawthorne avenue, Arbor Vitae street at Inglewood, city limits, to the Los Angeles-Redondo Rd., 5.38 miles; 5-in. concrete pavement reinforced with wire mesh 20 ft. wide. Entire length, 28,140 ft., of which 14,031 will have 5-in. disintegrated granite base. Contract price, $224,000.

Cal., San Anselmo—A. J. Raisch, 46 Kearney street, San Francisco, awarded contract for paving Red Hill and Ross Landing Rd.; also San Rafael and Olema Rd., Marion Co., with 6-in. concrete base and 1½-in. asphalt concrete surface, at $99,563.

Cal., Susanville—Warren Bros., Boston, Mass., awarded contract for paving streets and constructing cement walks here, at $191,256.

Cal., Visalia—Rebell Constr. Co., Fresno, awarded contract for grading and paving with concrete Yettem-Elderwood Co. Hwy., about 10 miles, county to furnish materials, at $121,238.

Ga., Blackshear—Brooks-Calloway Co., Healy Bldg., Atlanta, Ga., awarded contract to construct 8.93 miles sand-clay road, building reinforced concrete bride, etc., at $82 000.

Ia., Ames—Ira Cox, Sioux Falls, S. D., awarded contract for 23 miles graveling, at $70,000.

Ia., Carroll—Peterson, Shirley & Gunther, 1217 W. O. W. Bldg., Omaha, Neb., awarded contract for grading 19 miles Coon Rapids-Dedham-Templeton-Manning Rd., at $125,266.

Ia., Vinton—Moore-Young Constr. Co., Waterloo, awarded contract for paving 9 miles of county road, at $120,971.

Kans., Wichita—Ritchie Bros. and C. B. Ramsey, Wichita, awarded contracts for paving various streets here, at about $150,000.

Ky., Harlan—Geo. M. Eady Co., Louisville, Ky., awarded contract to construct 4-mile road; Kentucky rock asphalt, at $99,752.

La., New Orleans—City let contract for improving (1) Broad street, Canal to New Basin Canal; (2) portion of Sycamore; (3) S. Claiborne avenue; (4) Broad street; (5 S. Claiborne; (6) Magazine street; (7) Calliope street; (8) Julia street, (a) paving, (b) subsurf. drains to Craven & Lang, 1015 Hibernia Bank Bldg.; (1a) $165,953, (2a) $3,601; (3a) $171,468; (4a) $101,696; (5a) $200,821; (6a) $277,971; (7a) $34,920; (8a) $23,529; M. Mitchell, 2646 Banks street, (1b) $69,830, (3b) $94,473; C. W. Kreher, 300 S. Clarke street, (2b) $5,214, (7b) $11,641; E. Egans Sons, 1338 Canal street, (4b) $111,704, (6b) $181,644, (8b) $24,098; Crescent Contg. Co., Inc., (5b) $283,755.

Me., Augusta—Greenwood Constr. Co., Skowhegan, awarded contract for paving state highway, gravel, Littleton, at $117,987.

Mass., Brighton—Simpson Bros., Corp., awarded contract for new smooth pavement in Market street, Brighton-Washington street across Western avenue, and in Arlington street, Brighton from Market street across Leicester street, at $97,742.

Mich., Lansing—M. C. Hull, Dryden, awarded contract for road 21-12, C-D, St. Clair Co., for grading and draining struc-

tures at 7.592 miles, at $38,154; Herbert Campbell & Son, Port Huron, awarded contract for road 21-13, E-F, St. Clair, grading and draining structures, 6.056 miles, at $34,-953; Cook & Clark, Grand Rapids, contract for road No. 85-1, Montcalm, for B gravel, 6.145 miles at $74,971.

Mich., Lansing—State Hwy. Dept., Lansing, let contract for grading, draining and surfacing 1.582 miles State Trunk Line Rd., 10-19, 20 ft. wide, to Board Rd. Commrs., Wayne Co., Detroit, at $115,563.

Minn., Hibbing—General Contg. Co., Minneapolis, awarded contract for 21,000 sq. yds. Warrenite-Bitu. pavement.

Minn., Minneapolis—City will expend $1,-000,000 for various kinds of paving. Work will be done by day labor under supervision of E. R. Dutton, Asst. City Engineer.

Minn., Shakopee—John Cox, 567 Gilfillan Bldg., St. Paul, awarded contract for F. A. P. 93, St. Rd. 9, at $102,448; 7 miles long.

Minn., Walker—Latvala, Lidberg & Lake awarded contract for construction of 15-mile road from Pike Bay, on east side of Cass Lake, to Bena, at $145,000.

Neb., Omaha—Peterson, Shirley & Gunther awarded contract for building 4.257 miles Lake Andes-Platte-Chamberlain Rd., F. A. Proj. 68, at $30,318; W. P. Shipman Constr. Co., 209 Iowa Bldg., Sioux City, awarded contract for gravel surfacing 16.7 miles Parker-Centerville Rd., Parker to Viborg, at $98,749.

N. Y., Brooklyn—Sicilian Asph. Paving Co., 47 Park Row, New York City, awarded contract for regulating and repaving Linder street, at $21,41; 72nd street, 3rd to 6th avenues, to Brooklyn Alcatraz Asph. Co., 409 Hamilton avenue, at $108,265.

N. Y., New York—H. H. Curran, president Manhattan Boro, let contracts for regulating and repaving Lexington avenue and 125th street, First to Second avenues, to W. J. Fitzgerald, 150 Nassau street, at $62,164 and $49,630, respectively; 125th street, Second to Third avenues, and Lexington avenue, to P. J. Kearns, 2306 Creston avenue, at $41,727 and $9,974, respectively; Washington street, to O'Rourke Constr. Co., at $218,413; E. 24th street, to Burnside Contg. Co., 270 Burnside avenue, at $29,085.

N. Y., Poughkeepsie—Rosoff Engrg. Co., Inc., Park Row Bldg., N. Y. City, awarded contract for constructing road 1396, Nassau Co.; road 5588-B, Green Co. Rd.; 1535, Rockland Co., total of 0.59 miles concrete, at $30,743, and road 5649, Rockland Co., 0.50 miles, concrete, at $43,817; R. W. S. Corp., 30 Church street, N. Y. City, low bidder for road 1208, Suffolk Co., 4½ miles concrete pavement, and completing trimming shoulders and cleaning, 0.57 miles, at $179,955.

N. Y., St. George, S. I.—C. Vanderbilt, Ellzabeth street, W. New Brighton, awarded contract for repaving Richmond Turnpike, concrete, at $108,940.

N. C., Burgaw—Potter & Boyd, Charlotte, N. C., awarded contract to construct 27 miles Wilmington-Goldsboro Rd., gravel, concrete brdgs., etc., at $235,000.

N. C., Charlotte—Simmons Constr. Co., Charlotte, awarded contract for Improvement of 4.59 miles of road between point 1 mile north of Matthews and Mecklenburg counties, at about $170,000.

N. C., Greensboro—St. Hwy. Comn., Div. Office, let contract for improving 9.64 miles F. A. Proj. 101B, 18 ft. wide, Randolph Co., and 21.82 mile road between Pittsboro and Chatham-Randolph counties, line 18 ft. wide, Chatham Co., to J. T. Plott, Greensboro, at $62,500 and $125,370, respectively; 5-mile road from Sparta to Clade Creek, F. A. Proj. 125A, 12 ft. wide, Alleghany Co., to W. L. Graham, Mt. Ulla, at $139,-510; 11.93 mile road from Virginia state line to Yanceyville, F. A. Proj. 112, 18 ft. wide, Caswell Co., to J. M. Gregory & Co., Laurens, S. C., at $63,300.

N. C., High Point—R. G. Lassiter, Norfolk, Va., awarded contract for 7,000 sq. yds. Warrenite-Bitu. pavement on 5-in. concrete foundation; also contract for 21,-000 sq. yds. Warrenite-Bitu. pavement on 5-in. concrete foundation, in Guilford Co.

N. C., Nashville—R. G. Lassiter Co., Raleigh, awarded contract to construct 25,000 sq. yds. streets, at about $125,000.

N. C., Newton—G. R. Martin, N. Kerr street, Salisbury, awarded contract for grading, draining and paving Main, College et al. streets, involving 25,000 sq. yds. concrete paving, at $2.70 per sq. yd., 26,400 lin. ft. concrete walk, at $1.75, 31,600 lin. ft. comb. concrete curb and gutter, at $1.25, etc., total about $100,000.

N. C., Pittsboro—J. T. Plott, Greensboro, awarded contract to construct 21.82 miles topsoil, gravel or artificial sand, clay surfacing road, Proj. 99-B, at $125,590.

N. C., Sparta—W. E. Graham, Mount Ulla, N. C., awarded contract to construct 5 miles roadway, waterbound macadam, bridges, Proj. 125, at $102,780.

Ohio, Portsmouth—S. Monroe & Sons, Portsmouth, awarded contract for grading, building bridges and culverts and paving 1.99 miles Sec. B, Portsmouth-Oak Hill Rd., monolithic brk., $96,861; 1.794 miles Sec. A-3, Portsmouth-Jackson Rd., monolithic brk., at $94,894; A. E. Simpson, Portsmouth; 2.998 miles Sec. B-1, Portsmouth-Lucasville Rd., waterbound gravel, $48,994.

Pa., Harrisburg—State Hwy. Dept. let contract for repaving Route 68, Indiana Co., to McCrady Bros., Sixth street, Braddock, at $248,648; Route 11, Luzerben Co., to H. B. Sproul Constr. Co., Inc., 218 Adams avenue, Scranton, at $109,467; Route 176, Lycoming Co., to R. J. DeLong, 229 W. Fourth street, Wilmington, at $44,696; Route 181, North and South Strabane Twp., Washington Co., to Burgess & Dorrier, Scottsville, Ga., at $31,495.

Pa., Harrisburg—J. B. Reed Co., McKees Rocks, awarded contract for 4,375 ft. road between Rochester and Freedom, at $77,-211; 3,641 ft. in Economy Twp., at $59,-849; S. B. Markley, New Brighton, contract for 11,097 ft., Rochester, at $149,322.

Pa., Philadelphia—Barber Asph. Paving Co. awarded contract for paving Seventy-third street, Elmwood to Gray's avenue, at $13,150; Twentieth street, Church Lane to Godfrey avenue, at $24,050, and Sixtieth street, Jefferson to Lancaster, at $24,360.

Pa., Philadelphia—Union Paving Co. awarded contract for street repairs, at $250,000.

Pa., Pittsburgh—M. O'Herron & Co., S. First and McKean streets, awarded contract for grading and paving Carson street, Smithfield to Seventh streets, at $104,886.

Pa., Tullytown—B. Foster Co., Pittsburgh, awarded contract for building 7,180 ft. Main street, concrete, part of Penn. State Hwy., at $117,371.

S. C., Charleston—Commrs. Charleston County will construct 7-mile Mary and Johns Island Rd.; concrete. About $400,-000. Work by day labor. J. W. Martin, Charleston, Engr.

S. C., Columbia—Slattery & Henry, Greenville, awarded contract for building 2-mile road from Greenville to Jones Store, north of here; concrete, at about $113,000.

Tex., Cleburne—F. S. Harris Constr. Co., Ft. Worth, Tex., awarded contract to construct 20 miles Cleburne and Dallas Rd. and 8 miles Godlet and Cresson Rd., at $211,918.

Tex., Franklin—Harris & Powell, Tyler, awarded contract for grading, surfacing and building concrete and steel bridges and concrete culverts on 17.99 miles Highway 14, Nesbit, to 2 miles north of Wheelock, 15 ft. wide, at $204,136, including 10 percent for engineering and contingencies.

Tex., Jourdanton—W. T. Montgomery, Alamo Bank Bldg., SanAntonio, awarded contract for grading, surfacing and draining 13.47 miles Hwy. 9, from Pleasanton to Bexar Co., 16 ft. wide, at $187,639, including 10 percent for engineering and contingencies; also freight charges on gravel.

Tex., Mt. Pleasant—Wilder & O'Neal awarded contract for construction of 20.2 miles Highway No. 35, at $209,321.

SEWERAGE AND SEWAGE TREATMENT

Ariz., Yuma—C. Fisher, 328 Willetta street, Phoenix, awarded contract for building sewerage system in District 3, involving 39,820 ft. 4-20 in. vitr. clay pipe, 8 flush tanks, 52 manholes, 16x16 ft. concrete pump house and pumping unit complete, at $139,461.

Cal., Fullerton—W. Ledbetter, P. E. Bldg., Los Angeles, awarded contract for building sludge tank, screening plant, pipe lines and channels, at $17,374.

Cal., Yuma—Gordon Const. Co., Century Bldg., Denver, awarded contract for building sanitary sewerage system, including septic tank, with necessary manholes, etc., at about $60,000.

Ill., Chicago—T. J. Forschner Contg. Co., 125th street and Michigan avenue, city, awarded contract for construction of sewage treatment plant, by San. Dist. of Chicago, at $4,906,527; American Sewer & Drain Constr. Co., 2816 N. Washtenaw avenue, awarded contract for sewage conduits, at $588,227.

Ind., New Castle—Charles W. Minnick awarded contract for installation of sewer on E. Plum street, with a number of branches and intersecting streets, at $14,-

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